CalComp Model 1039 Drum Plotter Maintenance

technical manual

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Part No. 10219-901-002-2

MODEL 1039 DRUM PLOTTER
MAINTENANCE MANUAL

August 1978

CALCOMP
California Computer Products, Inc.
2411 W. La Palma, Anaheim, CA 92801

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-1	Revised and updated to current configuration.
10219-901-002-2	Basic part number change from 10219-901-912. (Microfiche edition: P/N 10219-921-002)
	Revised the Encoder Bias and Gain Adjustments.

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SECTION 1

INSTALLATION AND MAINTENANCE

This section describes the controls and indicators and contains instructions for plotter installation, mechanical maintenance, and electrical maintenance. Access for adjustments and for removal and replacement of components in the plotter is gained by removing the endbells and the rear panel (see Figures 1-1 and 1-2).

Each endbell is held in place by five screws, three across the bottom and two at the top corners. The rear panel is held in place by screws around the perimeter.

The electronics (accessible when the rear panel is removed) is held in place by screws through the back flanges on the chassis; the front flanges of the chassis are slipped under hold-down strips attached to the base of the cabinet. Removing the screws allows a chassis to be pulled out of the cabinet and moved about within the constraints of the service loops in the cables. The power supply chassis is accessible when the left endbell is removed.

CONTROLS AND INDICATORS

The plotter operator controls are located as follows:

- Right operator control panel, located on the right endbell
- Left operator control panel, located on the left endbell
- Plot Display switch, located under the right endbell
- Input panel, located at the rear of the plotter

Right Operator Control Panel

The right operator control panel (see Figure 1-3) contains switches to manually move the plotter in the ±X or ±Y direction, manually raise or lower the pens, select the pen force, enable or disable the manual controls of the panel, and enable or disable the feed and takeup servos. Table 1-1 describes the switch functions for the right operator control panel.

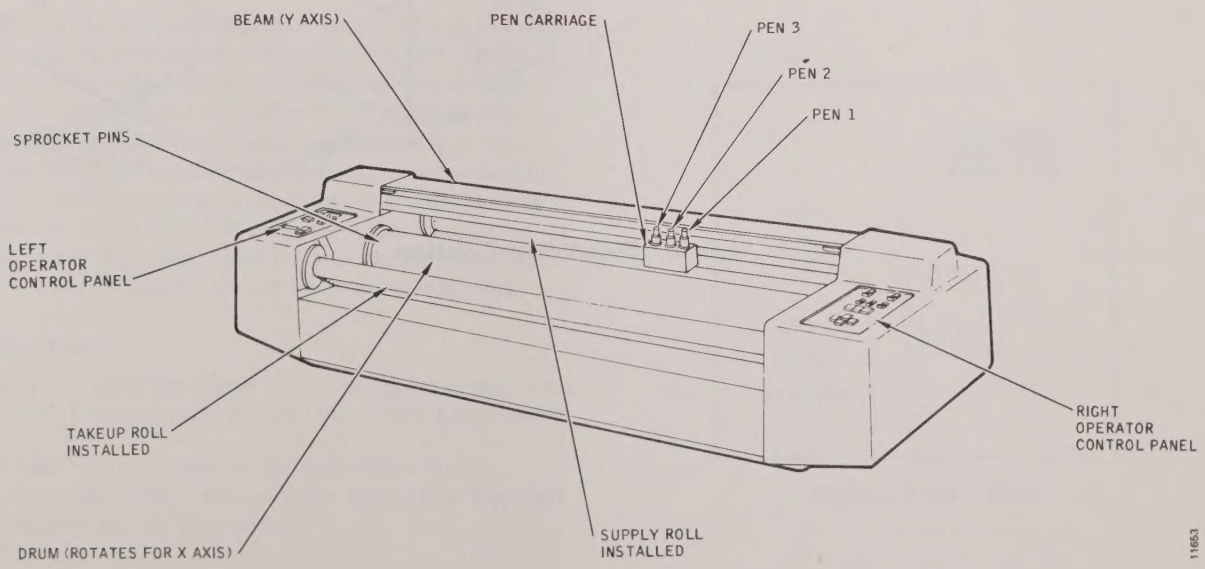


Figure 1-1. Front View of Plotter

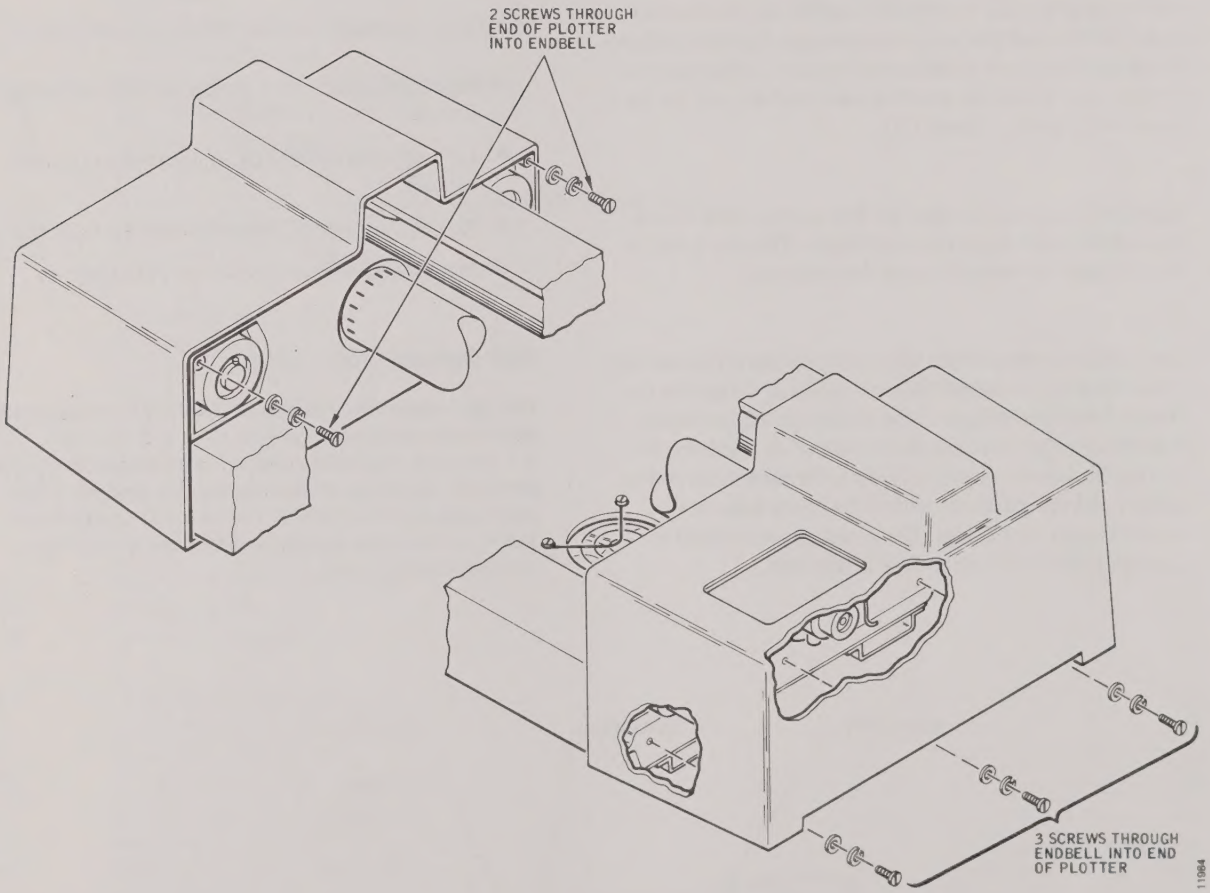


Figure 1-2. Endbell Screw Locations

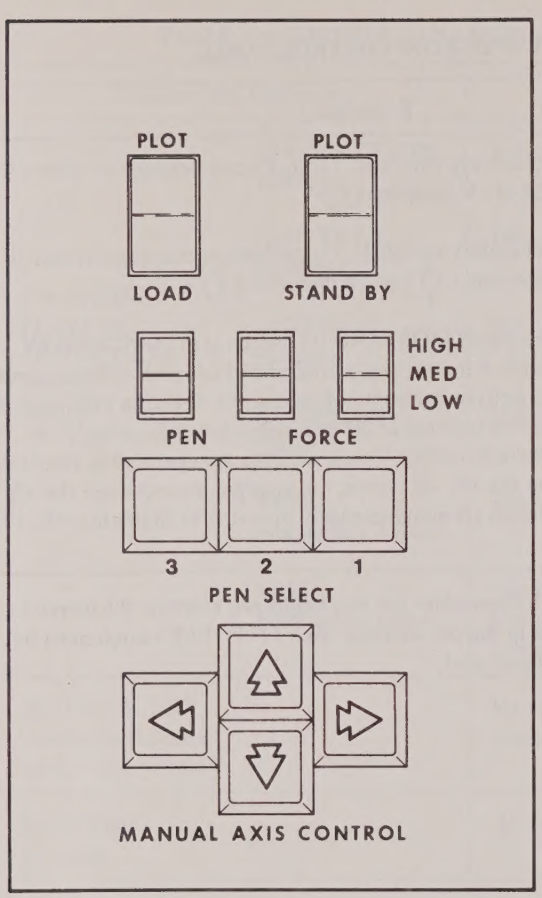


Figure 1-3. Right Operator Control Panel

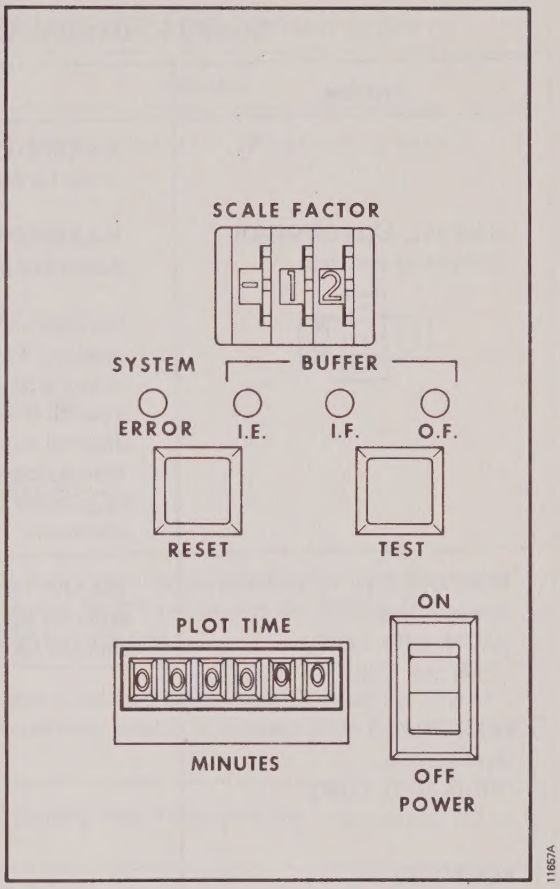


Figure 1-4. Left Operator Control Panel – All Options

Left Operator Control Panel

The left operator control panel is shown in Figure 1-4 with the main POWER switch and options. The OPC (Online Plotter Controller) option provides the plotter with an online capability that uses either RS232 standard serial interface or IEEE488 standard parallel interface. The Scale Factor option allows the operator to compensate in the Y axis for shrinkage or expansion of gridded plotting material. The PLOT TIME indicator option records the time spent in plotting. Table 1-2 describes the switch and indicator functions for the left operator control panel.

Input Panel

The Input Panel (see Figure 1-5) is located at the rear of the plotter. The input panel contains the following components:

- Two fuses – one for the optional Online Plotter Controller (OPC) and one for the plotter (See Electrical Maintenance for fuse values).
- PLOT TIME meter – records cumulative plotting time. The meter has a 1000-hour capacity.

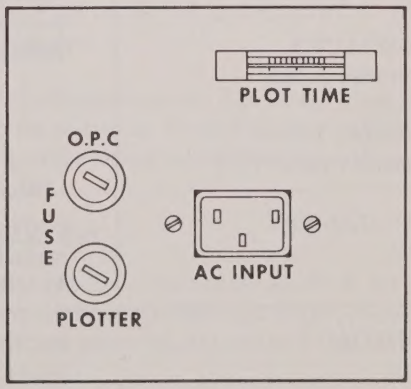


Figure 1-5. Input Panel

- Power Plug – input single-phase power to the OPC and plotter.

TABLE 1-1. CONTROLS FOR RIGHT OPERATOR CONTROL PANEL

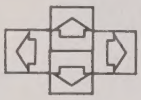
Switches	Function
MANUAL AXIS CONTROL momentary switches 	X-AXIS CONTROL momentary switches: Control drum rotation to draw a line in the +X direction (⇨) or -X direction (⇦). Y-AXIS CONTROL momentary switches: Control pen carriage movement to draw a line in the +Y direction (⇧) or -Y direction (⇩). Switches are active when the PLOT/STAND BY switch is in the STAND BY position. When each switch is momentarily pressed and released, a line composed of two 0.05 mm (0.002 inch) increments is drawn in the direction indicated. If a switch is held down, a line is drawn at 40 millimeters/second 1.6 ips).* A diagonal move occurs if the X and the Y axis switches are operated in combination. A diagonal move in the +X, -Y vector, for example, occurs when the +X (⇨) and -Y (⇩) switches are simultaneously operated to simulate a +X, -Y command.
PEN FORCE 1 three-position (HIGH, MED, LOW) rocker arm switch PEN FORCE 2 three-position (HIGH, MED, LOW) rocker arm switch PEN FORCE 3 three-position (HIGH, MED, LOW) rocker arm switch	The PEN FORCE switch determines the pen holddown current. Whenever a different pen is installed in the pen carriage, the PEN FORCE switch must be adjusted for the type of pen used.
PEN SELECT 1 momentary switch PEN SELECT 2 momentary switch PEN SELECT 3 momentary switch	If a pen is in the up position, PEN SELECT for that pen lowers it and raises any other pen. If a pen is in the down position, PEN SELECT for that pen raises it. Switches are active when the PLOT/STAND BY switch is in the STAND BY position.
PLOT/STAND BY Switch	PLOT: Enables data input circuits to receive coded commands. Disables the manual controls and resets the manual pen select. STAND BY: Enables the manual controls. Disables data input circuits.
PLOT/LOAD Switch	PLOT: Enables the X and Y axis servos and the paper supply and takeup servos after a time delay. LOAD: Allows the operator to load plotting paper by disabling the X and Y axis servos and the paper supply and takeup servos. The vacuum fan remains operating and the plotter electronics is reset.
*The maximum axial speed during automatic plotting is 112 millimeters/second or 4.41 ips.	

TABLE 1-2. CONTROLS AND INDICATORS FOR LEFT OPERATOR CONTROL PANEL

Switches and Indicators		Function
For ONLINE PLOTTER CONTROLLER (OPC) Option	SYSTEM ERROR indicator	Indicates logic or data error in the OPC. Requires reset action
	BUFFER I.F. indicator	OPC Input buffer full
	BUFFER I.E. indicator	OPC Input buffer empty
	BUFFER O.F. indicator	OPC Output buffer full
	RESET momentary switch	Resets logic in the OPC
	TEST momentary switch	Causes the plotting of a test program stored in the OPC. The test is started by pressing the RESET switch with the TEST switch and releasing the RESET switch first.
SCALE FACTOR thumbwheel switch with ± sign position		Manually compensates for media error in the Y axis only. Enables adjustment of the carriage positional accuracy up to ±64 millimeters.
PLOT TIME indicator		Accrues elapsed plotting time – not resettable
ON/OFF POWER		Controls power to the unit.

Plot Display Switch

The Plot Display switch, located below the right endbell, reverses the direction of rotation of the takeup roll. The two-position switch must be in one position when the plotting material is rolled up on the takeup roll. The switch must be in the other position for the Plot Display option where the plotting material is allowed to extend down the front of the plotter.

The proper position of the Plot Display switch is determined by observing the direction of rotation of the takeup roll.

1. Ensure an unbroken light path between the lamp and the sensors that control the direction of rotation of the takeup servo.

2. Set the PLOT/LOAD switch to PLOT and the PLOT/STAND BY switch to STAND BY.

3. If the plotting material is to be rolled up on the takeup roll, set the Plot Display switch so that the top of the takeup roll rotates toward the front of the plotter.

4. If the plotting material is to extend down the front of the plotter, set the Plot Display switch so that the top of the takeup roll rotates toward the rear of the plotter.

INSTALLATION

Installation consists of placing the plotter in the customer's workroom adjacent to an electrical outlet, checking plotter operation, and connecting the plotter to the data source.

Placement

The plotter should be placed on a table that raises the controls to a height comfortable for the operator and provides sufficient area for access to the electronics

in the back of the cabinet. (A table 28 to 30 inches deep will provide room for servicing the electronics assemblies.)

CAUTION

Do not attempt to lift the plotter by the beam or the endbells.

Before connecting the power cable at the input panel, measure the input voltage. Ensure that the transformer taps are jumpered for this voltage.

The I/O cable is connected to the signal panel at the rear of the plotter. For the 500 series interface, use cable mounted connector P/N 10020-404-000 (Cannon P/N SK19-21C-5/8). For the 936 interface use cable mounted connector ELCO P/N 00-8016-056-000-723. If the OPC is installed, use cable assembly 20593-401-000 (CMS 2024-4) for the IEEE-488-1975 parallel interface. Likewise if the OPC is installed, use cable assembly 20535-401-5XX (-500 for 25 feet ±6 inches or -511 for 10 feet ±6 inches) for the RS232 serial interface. See Model 906 Technical Manual (P/N 10212-921-003) for internal switch positions for the IEEE or RS232 interfaces.

Vacuum Baffle

The vacuum baffle is used to change the size of the fan opening (see Figure 1-6). This allows regulation of the vacuum/air pressure differential. Too great a differential may intensify the effects of paper skew, causing the paper to bunch up and wrinkle at one end of the takeup spool.

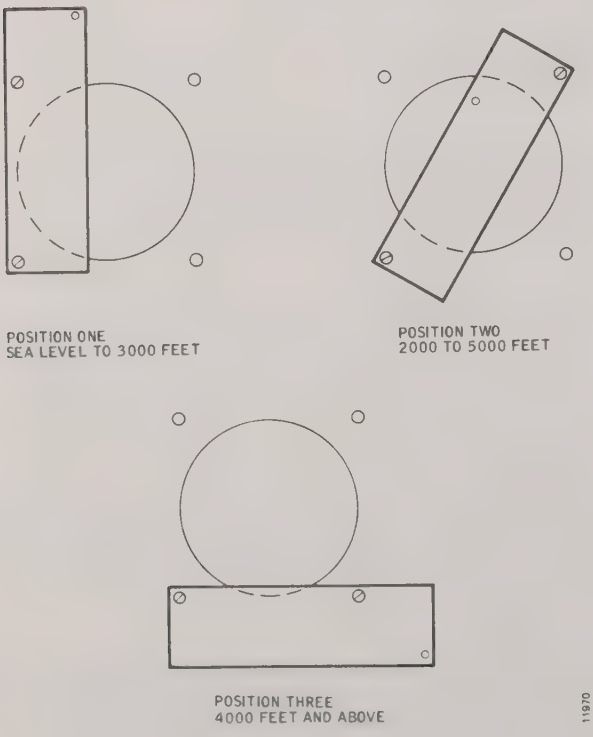


Figure 1-6. Vacuum Baffle Installation

Plotters are shipped with the baffle mounted in position one. During installation of the plotter, change the baffle to the position required for the altitude at the customer's site. If no more than two screws are removed at one time, it will not be necessary to remove the back panel from the plotter to make the change. (The screws hold the fan in place, and if more than two are removed, the fan will drop below the level at which the screw threads will engage the threads of the fan housing.) The vacuum baffle part number is 21591-203-000.

Checkout

Checkout consists of verifying operation of the plotter in both the standby and plot modes (no paper installed initially).

1. Set the PLOT/STAND BY switch to STAND BY, set the PLOT/LOAD switch to PLOT, and turn the plotter POWER switch to ON.
   - The fan motor will operate
   - The paper-loop detector light will be on
   - Both paper spools will rotate after an 2- to 4-second delay.
2. Checking the out-of-paper time delay:
   - Set the PLOT/STAND BY switch to PLOT and use data cards to block the light path for the front and rear paper servo phototransistors. Both paper spools should rotate.
   - Remove the data card blocking the front servo light path and observe that the front spool reverses direction and after 3 seconds both spools stop.
   - Replace the front data card and remove the rear data card. Observe that the rear spool reverses direction and after 3 seconds both spools stop.
   - Remove both data cards and set the PLOT/STAND BY switch to STAND BY.
3. Set the Plot Display switch so that the top of the takeup spool rotates toward the front of the plotter. This is the switch position used when the plotting material is rolled on the takeup spool.
4. Interrupt the light to the paper-loop sensors, each in turn. Upon complete interruption, the respective paper spool will reverse its rotation.
5. Set the PLOT/LOAD switch to LOAD and observe that the paper spools stop rotating.

6. Verify that the drum and carriage servos are also disabled by checking for free movement of each.

7. Plotting material may now be installed on the plotter:

   - Roll sufficient material onto the front spool to allow for the isolation loop between the spool and the drum.
   - Adjust the spool flanges to the paper edges, as required.
   - Make sure that the sprocket pins on the drum are engaged correctly with the sprocket holes in the paper. Refer to the operation manual for a detailed, paper-loading procedure.

8. Set the PLOT/LOAD switch to PLOT. Both the front and back paper loops should stabilize within 2- to 4-seconds.

9. Check the operation of the X-axis circuit.

   - Press the +X (⌓) pushbutton. The paper should move from the back to the front paper spool (feed to takeup).
   - Press the -X (⌔) pushbutton. The paper should move from the front to the back paper spool (takeup to feed).

10. Check the operation of the Y-axis circuit.

CAUTION

When power is on, do not reposition the pen carriage or drum by hand to avoid servo runaway.

   - Press and hold the -Y (⌷) pushbutton. The carriage will move toward the right end of the beam. Release the -Y (⌷) pushbutton.
   - Press and hold the +Y (⌶) pushbutton. The carriage will move toward the left end of the beam. Release the +Y (⌶) pushbutton.

11. Install a pen in the pen block, and use the manual controls to draw a line in each of the eight vectors (see Figure 1-7). Ensure that the proper pen force is used according to the table below:

CAUTION

Do not use a greater pen force than recommended. Damage to the pen, plotting material, and drum may result.

Pen Type	Pen Force
Ballpoint only	HIGH
Liquid Ink (Pen Size L8)	MED
Liquid Ink (Pen Sizes L3 thru L6)	MED or LOW
Nylon or Liquid Ink (Pen Size L2)	LOW

12. Set the PLOT/STAND BY switch to PLOT and if the Online Plotter Controller (OPC) is installed, run a test plot (see Figure 1-8). The test plot is started by pressing the RESET and TEST switches on the left operator control panel and releasing the reset switch first. The test plot is 73 centimeters (28.8 inches) square.

13. Turn off plotter power, and connect the plotter to the data source. Ensure the TTL/HL signal level switch on the Data I/O and Pen Driver board is positioned correctly (see 500 Series Interface in Section 3).

14. Turn on plotter power, set the PLOT/STAND BY switch to PLOT, set the PLOT/LOAD switch to PLOT, and activate the data source. The plotter should operate under data source control.

15. Set the PLOT/STAND BY switch to STAND BY, and turn off plotter power. Checkout is complete.

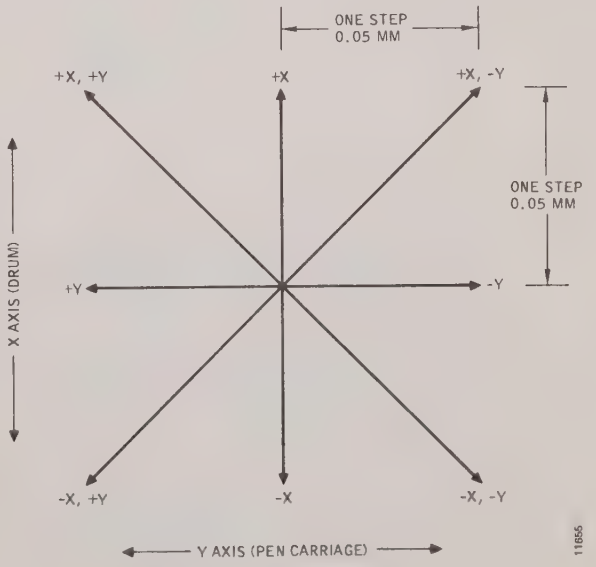


Figure 1-7. Basic Plotter Vectors

Figure 1-8. Online Plotter Controller (OPC) Test Plot

PREVENTIVE MAINTENANCE

To ensure reliable operation of the plotter, preventive maintenance (PM) should be performed at least every 6 months. The following PM requires approximately 1 hour:

1. Verify operation of the plotter by performing the plotter checkout (see Installation paragraph).

2 Clean, check, or repair as required.

- Clean external surfaces
- Clean and check plotter drum
- Check plotter gear mesh
- Check servomotor brushes (every 2000 to 2400 hours or after 1 year's use) see brush maintenance procedure.

3. Verify operation of the plotter before returning it to the customer.

MECHANICAL MAINTENANCE

Mechanical maintenance includes parts replacement and adjustment procedures. Refer to the assembly diagrams in Section 4, as necessary, when performing the following procedures.

Drum

The drum is driven through a gear coupling at the right end of the plotter. A spring-loaded shaft at the left end maintains the gear coupling. Replacement of the drum is in the reverse order of removal. When necessary, the drum may be cleaned with a solution of water and mild detergent prior to its reinstallation. The drum should be dried thoroughly with lint-free shop cloths prior to being installed in the plotter.

1. Turn off plotter power, and remove the pens from the pen block.
2. Push the carriage to the extreme right end of the beam.
3. Push the drum against the spring loading at the left end to disengage the gears at the right end. The drum need not be turned to disengage the gears.
4. Pull the right end of the drum forward and up, and pull the left end of the drum free of the bearing shaft. Do not contact the pen block with the drum. Lift the drum out of the plotter.

Drive Band

The drive band is used to transfer motion from the Y servomotor to the carriage. The band is wrapped around pulleys at the ends of the beam, and the ends of the band are connected

to the carriage (holes in the ends of the band are hooked over screwheads in the back of the carriage frontplate). The drive pulley, at the right end of the beam, is connected through a gear train to the motor; the idler pulley, at the left end of the beam, is used to apply tension to the band. The endbells and the pen block cover must be removed to service the band. Servicing consists of removal, replacement, and alignment.

WARNING

Do not attempt to remove or replace the band while power is connected to the plotter. Personal injury could result from accidental application of power to the motor drive circuits.

Note

Remove the pens from the pen block while servicing the drive band in order to protect the drum and pens from damage.

- **Band Removal**

1. Move the carriage to the extreme left end of the beam. (At the ends of the beam, the band can be depressed into the beam channel enough to clear the screwheads behind the carriage frontplate.)

2. Loosen the drive band adjustment screws at the left end of the beam assembly (see Figure 1-9). Do not relieve tension from half the band all at once; alternate half turns between the adjustment screws until tension is relieved.

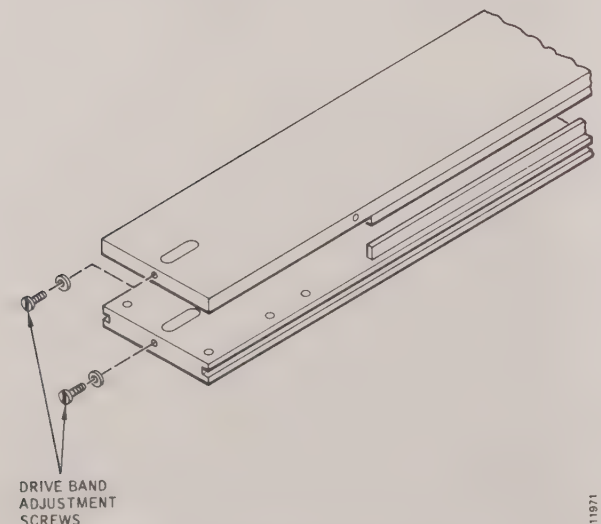


Figure 1-9. Drive Band Adjustment Screws

3. Unhook the band from the left end of the carriage by pressing the band into the beam and moving the carriage away from the end of the band.

4. Move the carriage to the extreme right end of the beam, and unhook the band from the right end of the carriage by pressing the band into the beam and moving the carriage away from the end of the band.

5. Carefully remove the band from the pulleys and the beam.

- **Band Replacement**

1. Thread the band around the pulleys and the beam.

2. Move the carriage to the left end of the beam, and hook the band to the left end of the carriage by pressing the band into the beam and moving the carriage over the end of the band. Release pressure from the band so that the hole in the band can be hooked over the screw in the back of the carriage frontplate.

3. Move the carriage to the right end of the beam, and hook the band to the right end of the carriage by pressing the band into the beam and moving the carriage over the end of the band. Release pressure from the band so that the hole in the band can be hooked over the screw in the back of the carriage frontplate.

4. Make sure that the front surface of the band is seated against the back surface of the carriage frontplate. If the band is spaced away from the carriage, the band may rub on and score the beam.

5. Pull the idler pulley until the band is taut, and then hand tighten the drive band adjustment screws to take up the slack.

6. Using a screwdriver, tighten both adjustment screws 2-1/2 turns each past the taut point. To avoid twisting the band, alternate half turns between the screws until the full adjustment is reached.

- **Band Alignment**

1. Turn on plotter power.

2. Use the direction controls to move the carriage back and forth the length of the beam while observing tracking of the band over the idler pulley.

3. Use the drive band adjustment screws to adjust the tilt of the idler pulley. If the band rode up on the pulley (in the previous step), loosen the bottom adjustment screw slightly, and tighten the top screw. Conversely, if the band rode down on the pulley, loosen the top screw slightly and tighten the bottom one.

4. Repeat steps 2 and 3, as necessary, until the band tracks correctly.

5. Check plotter operation.

Band Drive Pulley

Drive pulley servicing consists of replacing the ring gear, the drive pulley, or the pulley shaft (see assembly drawings in Section 4).

1. Disconnect and remove the drive band from the right end of the beam.
2. Remove the Y-axis servomotor assembly. Refer to the Motor Encoder Servicing procedures.
3. Remove the motor support assembly from the beam. This assembly comprises the ring gear, the drive pulley, and the pulley shaft attached to the motor support plate.
4. Remove and replace the ring gear, the drive pulley, or the pulley shaft, as required. Use the same number of plain washers as were used in the original assembly between the snap ring on the pulley shaft and the drive pulley assembly. These plain washers serve as shims and allow adjustment of the distance between the pulley and the motor support plate.
5. Mount the motor support assembly on the beam.
6. Connect the drive band to the carriage.
7. Replace the Y-axis servomotor.
8. Adjust the alignment of the band.
9. Check the operation of the plotter.

Band Idler Pulley

Idler pulley servicing consists of replacing the idler pulley assembly or the pulley shaft (see assembly drawings in Section 4). Service the idler pulley in the following manner:

1. Disconnect and remove the drive band from the left end of the beam.
2. Remove the adjustment screws.
3. Push the pulley shaft through the beam.
4. Replace the idler pulley assembly or the pulley shaft, as required. Shim the end play of the idler pulley to 0.002 inch minimum, 0.012 inch maximum.
5. Reinstall the adjustment screws. Apply a light coating of Shell Aero Seal grease to the screw threads before the screws are installed.
6. Connect the drive band to the carriage.
7. Adjust the alignment of the band.
8. Check the operation of the plotter.

Pen Block

The pen block contains the three pens and their pen coils. The pen coil wiring passes through a connector (P5010) on the carriage. The pen block is attached to the carriage by two number 10 Allen head screws.

- **Pen Block Removal and Replacement**

1. Ensure that the plotter POWER switch is OFF.
2. Remove the drum and pens to prevent damage.
3. Remove the two number 10 Allen head screws located at the base of the pen block.
4. Disconnect the connector that carries the pen coil wiring.
5. The pen block can now be lifted off its platform.
6. Replacement is in the reverse order of removal. During replacement, prevent twisting of the pen block by holding it against the carriage while tightening the two number 10 Allen head screws.

Pen Height Adjustment

The height of each pen must be adjusted to prevent damage to the drum or to the pen. Use the following procedure to set the pen height between 0.012 and 0.015 inch.

1. Ensure that the plotter POWER switch is OFF.
2. Remove the pen block cover that is held on by two screws, one on each side.
3. Remove all pens except the one being adjusted.
4. Hold two data cards (one on top of the other) flat on the drum.
5. Move the pen carriage over the cards, and adjust the pen height until the pen writes smoothly on the two-card-thickness surface (0.014 inch). The adjustments are located above and behind each pen.

Note

After each adjustment, tap the top of the pen to ensure that the pen has moved to its new position.

6. Repeat for each pen position.

Carriage Limit Switches

The carriage limit switches are mounted at each end of the Y axis and prevent inadvertent overtravel of the pen carriage. While a limit switch is activated, further carriage movement in the overtravel direction is inhibited. Carriage movement in the other direction is not affected. The switches consist of an LED and phototransistor. At either end of the Y axis, the carriage interrupts the light path from the LED to the phototransistor and activates the inhibit circuitry.

The carriage limit switches have elliptical mounting holes to allow for adjustment. The switches should be adjusted to stop plus or minus Y axis travel before the carriage contacts the rubber carriage stop. Check the adjustment by operating the +Y then the -Y manual axis control.

During beam alignment or carriage removal, the two screws that hold the carriage to the carriage way are loosened. When these screws are losened, that part of the carriage that activates the limit switches may be moved out of position. As a result, the beam alignment and carriage limit switch activation must be adjusted at the same time.

Carriage and Carriage Cable

The carriage is held in place on the beam rails by four concave bearings, one at each corner of the carriage. Removing the bracket with the two rear bearings frees the carriage from the beam. However, the carriage cable pcb attached to the back of the carriage prevents removal of the carriage from the beam except at the channel relief at the left end. The pcb can be removed from the carriage only after the carriage is removed from the beam. Also, the cable (part of the pcb assembly) is attached to the beam with double-sided, pressure-sensitive tape and with a cable clamp at the point of exit from the feam (see Figure 1-10). The tape may retain its adhesiveness for a second usage but should be replaced if it is no longer tacky.

Replacement is in the reverse order of removal; make sure that the carriage bearings are seated on the guide rails before tightening the bracket screws. For carriage alignment, refer to Beam Replacement and Alignment. Upon completion of replacement, check plotter operation. Remove the carriage and carriage cable in the following manner:

1. Turn off the plotter power, and remove the drive band.

2. To protect them from possible damage, remove the drum and all pens in the pen block.

3. Move the carriage to the left end of the beam over the channel relief.

4. Remove the left cam from the beam.

5. Remove the carriage bearing bracket from the rear of the carriage, and pull the carriage from the beam. (The bracket is held in place by two screws.)

Note

Succeeding steps detail removal of the carriage cable.

6. Remove the two screws that hold the carriage cable to the back of the carriage.

7. Carefully peel the cable from the double-sided, pressure-sensitive tape.

8. Gently pull the cable through and out of the beam.

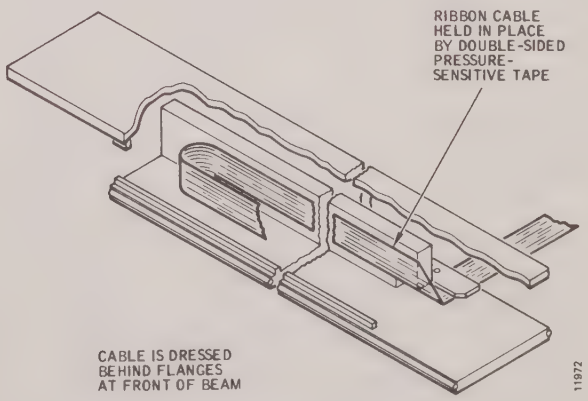

RIBBON CABLE HELD IN PLACE BY DOUBLE-SIDED PRESSURE-SENSITIVE TAPE
CABLE IS DRESSED BEHIND FLANGES AT FRONT OF BEAM
11972

Figure 1-10. Carriage Cable Installation

Beam

The beam provides a rigid support so that carriage movement is parallel to the axis of the drum. Rods attached to the beam are used as tracks for the carriage. Perform the removal and replacement procedures outlined below.

- **Beam Removal**

1. Remove the carriage and carriage cable.

2. Disconnect the Y servomotor cables.

3. Disconnect and remove the beam from the plothead. Two bolts hold the beam on the plothead.

- **Beam Replacement and Alignment**

1. Install the beam on the plothead; tighten the holddown bolts just snug.

2. Install the carriage cable and carriage. Do not install the pen block.

3. Remove the drum.

4. Install fixture adapter, part number 14393-204-000, to the carriage with two 10-32NF x 0.50 long socket head cap screws. Position the adapter against the carriage face similar to pen block installation.

5. Reinstall the drum.

6. Check fixture number 11398-211-011 to ensure that dial faces are set to zero when the contact tips are depressed flush with their corresponding surfaces.

7. Install fixture number 11398-211-011 to adapter, part number 14393-204-000; make sure that the fixture rests on the adapter pads before tightening the thumbscrews. See Figure 1-11.

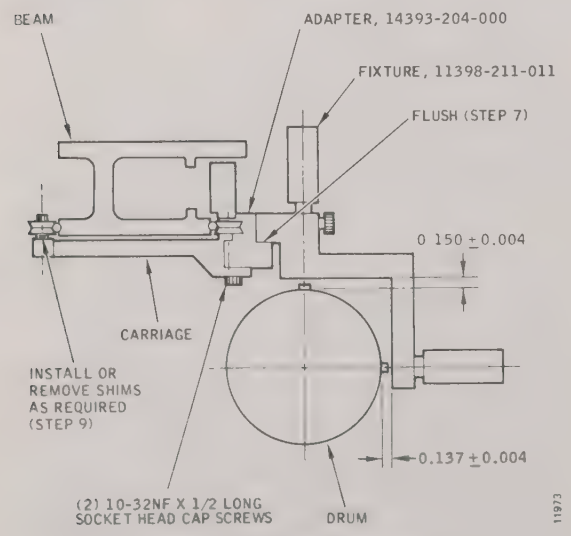


Figure 1-11. Beam Alignment

8. Check beam and carriage height. This dimension should be 0.150 ±0.004 inch at extreme ends of the plotting area on the drum. See Figure 1-11.

9. To adjust the dimension of the previous step, loosen the carriage spring, part number 14375-204-000, and move the carriage up or down to improve the indicator reading. If not enough adjustment is possible, then remove the carriage spring and install or remove shims, part number 72041-206-002, under guide bearings to achieve the 0.150 ±0.004 inch dimension. See Figure 1-11.

Note

Whenever the carriage spring is loosened, the carriage limit switch activation must be verified. With the beam alignment fixture installed, the limit switch activation is not possible. Sight down the limit switch to check alignment.

10. Check the beam locating indicator. This dimension should be 0.137 ±0.004 inch at the extreme ends of the plotting area on the drum. See Figure 1-11.

11. To adjust the dimension of the previous step, loosen beam holddown bolts and slide the beam back or forward to improve the indicator reading.

12. Fully tighten the drum holddown bolts.

13. Remove the alignment tool, and install the pen block.

14. Connect the Y servomotor cables (J6220 to A, J6210 to B), and replace the drive band.

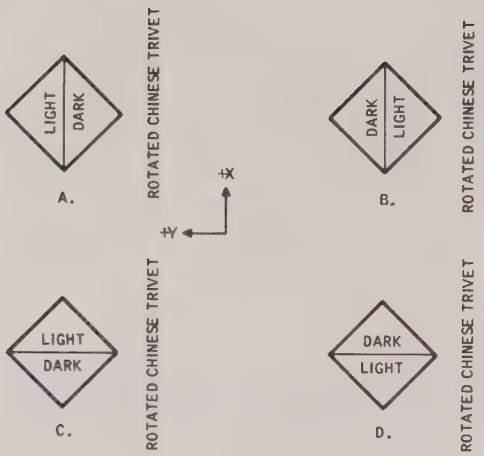
15. Check the alignment with a liquid-ink plot of the rotated trivet on Mylar to see any quadrant shading. The trivet is to be plotted at both sides of the plotting area. If shading is present, the beam or carriage needs readjusting in the direction indicated by the shading. See Figure 1-12.

Note

Any combination of shading in Figure 1-12, i.e., alternating quadrants being light and dark, indicates both beam and carriage need the corresponding adjustments.

Motor Encoders

Motor encoder servicing consists of removing and replacing the assembly and adjusting drive gear mesh. Removing the



A. MOVE THE BEAM TOWARD THE REAR OF THE PLOTTER.

B. MOVE THE BEAM TOWARD THE FRONT OF THE PLOTTER.

C. THE CARRIAGE BEARINGS ON THE LEFT SIDE AS VIEWED FROM THE FRONT OF THE PLOTTER NEED A SHIM (72041-206-002) ADDED.

D. THE CARRIAGE BEARINGS ON THE RIGHT SIDE AS VIEWED FROM THE FRONT OF THE PLOTTER NEED A SHIM (72041-206-002) ADDED. 11874

Figure 1-12. Beam and Carriage Adjustment Using Rotated Chinese Trivet

motor encoder comprises disconnecting the motor and encoder cables and removing the screws that attach the motor support. Replacement is the reverse of removal, with the gear mesh being adjusted before the mounting screws are tightened. Adjust the gear mesh in the following manner:

1. Tighten the mounting screws just enough to hold the assembly in place but so that the assembly can be moved about the pivot point.

2. Rotate the assembly on the pivot to mesh the gears. Check tightness of the mesh by rotating the drum or moving the carriage back and forth the length of the beam. Backlash can be checked by applying power to the plotter and rocking the drum or carriage (driven gear) manually against the motor (drive gear). Power will cause the motor to lock in place. The entire circumference of the driven gear can be checked in this manner by applying power, checking, turning off power, rotating the driven gear a small amount, and applying power again.

3. When mesh is adjusted correctly, tighten the mounting screws.

4. Check plotter operation.

Feed and Takeup Motors and Belts

The feed and takeup motors drive the feed and takeup spools respectively through O-ring belts. The motors are connected into dc-servo loops that maintain the isolation loops in the plotting paper on each side of the drum. The motors run in either one direction or the other, depending upon light or no light falling on a light-sensitive transistor in the servo loop. The paper in the isolation loop interrupts light from a lamp located under the drum. The motor mounting plates are identical, but the motors are mounted on opposite sides of the plates. Each motor drives its spool through two O-ring belts. When replacing belts, loosen the motor mounting plates so that the belts can be slipped over the end of the drive pulleys; make sure that the belts are not twisted. When replacing motors, make sure that the cables are connected to the correct pins (dc motors! – reversing leads causes a reversal of rotation), J6310 to pin 1 and J6320 to pin 2 on the takeup motor (front), and J6410 to pin 1 and J6420 to pin 2 on the feed motor (rear).

Paper Tracking

Paper is tracking correctly when it moves from one roll across the drum and onto the other roll without skew or wrinkles. Two adjustments are used to correct paper-tracking problems. The first compensates for slight variations in paper width by changing the distance between spool flanges; the second ensures alignment of the paper drive pulleys (right-hand spool flanges) with the drum pins. Adjusting for paper width should correct most tracking problems. Also, keep in mind that out-of-tolerance dimensions of the paper itself may cause tracking problems.

- **Paper Width Adjustment**

Hold the paper roll firmly while rotating the flange of the left-hand spool. (Clockwise rotation increases the distance between flanges.) The distance is adjusted correctly when one to three data punch cards can be slipped between the left-hand flange and the edge of the paper. Adjust both the feed and takeup spools.

- **Pulley/Pin Alignment Adjustment**

First, remove paper from the plotter (if installed). Then, insert the Paper and Drum Alignment Tool (P/N 20124-802-000-1) between the beam and the drum – the hole in the center of the tool will fit over a drum pin; and the notches near the ends of the tool will fit over the paper spool shafts. Alignment is correct when, with the tool pressed against the plotter side support (both plugs on the tool touching the side support), the faces of both paper drive pulleys contact the tool and a drum pin is visible in

the hole in the center of the tool (the hole is slightly larger than the pin, allowing some tolerance in drum adjustment). Lateral positions of the drive pulleys and the drum pins are adjusted by increasing or decreasing the number of flat washers (see Figure 1-13) between the pulleys or the spur gear mount and the plotter side support.

ELECTRICAL MAINTENANCE

Brushes

Two brushes are used in the motor. They are located inside the connector posts and are accessible when the cable connecting screws and the tops of the posts are removed.

1. Remove and identify the brushes so they can be returned to the same brush holder. Note the scribe mark on the brush; this provides you with an easy orientation mark.

2. Check brush springs for excessive distortion.

3. Check the brush length. If the brush is 5 millimeters (0.2 inch) long or less, the brush has attained expected life and should be replaced.

Note

We recommend that motors be returned to the factory for brush replacement. When new brushes are installed, these brushes are run in until the minimum contact area appears to be greater than 75% of the total brush area. (The run in period is from 6 to 8 hours, with no load on the shaft and at the motor's rated voltage, reversing direction approximately every minute.)

4. Replace the brushes in the sequence that they were taken out. It is important to install the brushes in the same holder and in its relative position, to be assured of proper performance upon initial running.

Fuses

The plotter has two fuses on the Input Panel. One fuse protects the Online Plotter Controller (OPC) if installed. The other fuse protects the plotter. The fuse values (see Table 1-3) depend on the input voltage.

The power supply (located in the left endbell) contains fuses in the transformer secondary. See Table 1-4.

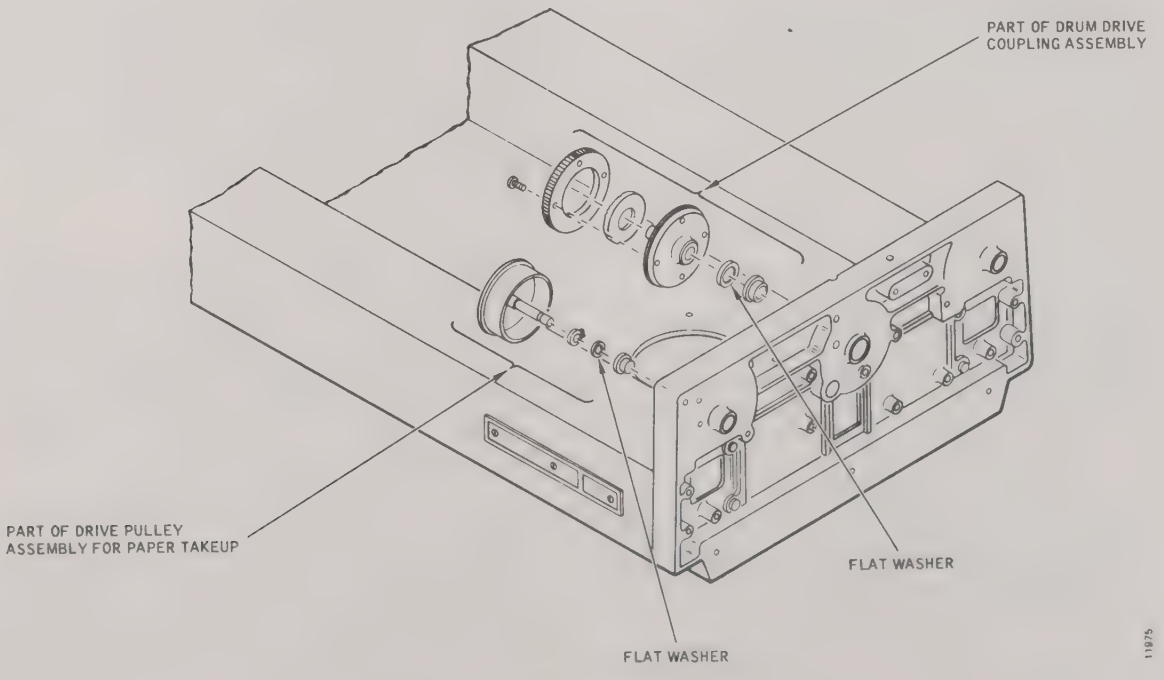


Figure 1-13. Pulley and Drum Pin Alignment

TABLE 1-3. INPUT PANEL FUSES

	Input Voltage	
Name	100/120 Volts	200/220/240 Volts
F0101 Plotter	3 Ampere	2 Ampere
F0102 OPC	3 Ampere	2 Ampere

TABLE 1-4. FUSES IN TRANSFORMER SECONDARY

Function	Item	Rating (Amperes)
±15 Volts	F3, F4	3
±14 Volts (unregulated)	F5, F6	5
+5 Volts	F7, F8	5

Input Voltage Transformer Taps

The plotter voltage requirements are matched to the available facility voltage by adding the proper jumper to the power supply terminal board. The terminal board (located in the left endbell) is jumpered according to Figure 1-14.

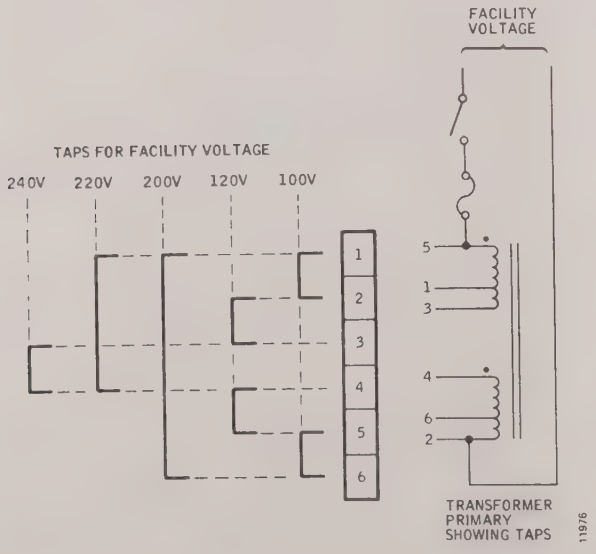


Figure 1-14. Input Voltage Transformer Taps

Frequency Adjustment

The clock generator circuit, located on assembly 20865-502, has an adjustment potentiometer (R56). Using an oscilloscope or frequency meter, the measurement at P2102-BB27 should be 250 microseconds ±6 microseconds (4 kilohertz ±100 hertz). Adjust R56 if necessary.

Axis Servo Adjustments

The axis servo adjustment procedure uses the ZERO and GAIN potentiometers (shown on sheet 6 of 20866-502-000). The procedure consists of substituting a shunt for the servomotor and using a DVM across the shunt to determine the motor current.

1. Ensure that plotter power is off.

2. Slide out the plotter electronics assembly and put pcb 20866-502-000 on an extender card.

3. Remove the right endbell and disconnect the X servomotor leads, J6120 from terminal A and J6110 from terminal B. If the adjustment is for the Y axis, disconnect the Y servomotor leads, J6220 from terminal A and J6210 from terminal B.

4. For the X adjustment, connect J6110 and J6120 to the load terminals of the shunt P/N 20196-802 (200 millivolts per 10 amperes). For the Y adjustment, use J6210 and J6220. The spade lugs are too small to fit entirely on the shunt terminals. Place the spade lugs under the washer for better contact.

CAUTION

When an axis servomotor is replaced by a shunt, do not turn the drum or move the pen carriage by hand. The movement will generate encoder feedback, which may damage components and give erroneous adjustment results. To correct the condition, momentarily turn the plotter power off.

5. Attach the DVM probes across the shunt at its sense terminals. Ensure DVM probes are ungrounded.

6. Set the PLOT/STAND BY switch to STAND BY, the PLOT/LOAD switch to PLOT, and turn the plotter power on.

7. Ensure that the DVM shows zero volt(±5 millivolts). If not, adjust the ZERO potentiometer R17 (for the X axis) or R18 (for the Y axis) found on pcb 20866-502-000.

Note

In the following steps, a plot motion command of one polarity is used to increase the circuit output, and a plot motion command of the opposite polarity (in lieu of negative feedback from the encoder) is used to reduce the output back to zero.

CAUTION

Avoid exposing the driver transistors to prolonged high current. In case of overheating, turn the plotter off and allow them to cool.

8. Momentarily press (tap) the positive plot motion command switch (or) and then the negative (or) one. This exercises the circuit; the output should have increased and then decreased to zero.

9. The servo low gain mode check:

   - When checking the X axis gain, tap the +X plot motion command switch once. The tap would normally produce a 0.004 inch movement on the +X axis if the servomotor were connected.
   - Verify that the shunt voltage drop is less than 10 millivolts. (0.5 ampere through the shunt produces 10 millivolt drop).
   - If necessary, adjust GAIN potentiometer R25 (for X axis) or R22 (for Y axis) on pcb 20866-502-000.

10. The servo high gain mode adjustment:

    - Turn off the plotter and remove one shot chip U82 (for X axis) or U78 (for Y axis) on pcb 20866-502-000.
    - Jumper pin 6 of the U82 socket to +5 volts (for X axis) or pin 6 of U79 (for Y axis).
    - Turn on the plotter.
    - Tap the positive plot motion command switch once.
    - Using GAIN potentiometer R25 (for X axis) or R22 (for Y axis), adjust the shunt voltage drop to 40 ±0.1 millivolts. Make the adjustment quickly to avoid transistor overheating.
    - Turn off the plotter, remove the jumper, and install the U82 chip or the U78 chip.

11. Reinstall the servomotor.

12. Repeat for Y axis.

Zero Adjustment for Pen Control

The current through each pen coil is adjusted to zero when no pen is selected. The following procedure gives the zero adjustment for pen 1 on assembly 20865-502-000, sheet 4.

1. Set the PLOT/STAND BY switch to STAND BY.
2. Verify that no pen is selected.
3. Using an oscilloscope (or DVM), measure the voltage across R27 (use R38 for pen 2, use R51 for pen 3). Ensure that the scope is ungrounded.
4. Adjust potentiometer R20 (use R31 for pen 2, use R44 for pen 3) so that the scope measures zero volt.

Gain Adjustment for Pen Control

The current through each pen coil is adjusted for 80 milliamperes under the following conditions: (1) the pen is selected and (2) the corresponding PEN FORCE switch is LOW. The following procedure gives the gain adjustment for pen 1 on assembly 20865-502-000, sheet 4.

1. Set the PLOT/STAND BY switch to STAND BY.
2. Set all PEN FORCE switches to LOW. Remove all pens for this test.
3. Select pen 1 (if adjusting pen 2, select pen 2 – if adjusting pen 3, select pen 3).
4. Using an oscilloscope (or DVM), measure the voltage across R27 (use R38 for pen 2, use R51 for pen 3). Ensure that the scope is ungrounded.
5. Adjust potentiometer R26 (use R37 for pen 2, use R50 for pen 3) so that the scope measures 19.2 millivolts (80 milliamperes times 0.24 ohm).
6. Verify that the PEN FORCE switch at MEDIUM and HIGH produce a voltage in step 4 of 24 millivolts and 139 millivolts respectively. Do not adjust the potentiometers at MEDIUM and HIGH settings.

The pen coil current for each PEN FORCE switch setting is as follows: LOW, 80 ma; MEDIUM, 100 ma; and HIGH, 580 ma.

ENCODER BIAS AND GAIN ADJUSTMENTS

The X axis servomotor and the Y axis servomotor each have an encoder attached to its motor shaft. Each encoder generates a phase A and a phase B. Each phase has a bias and a gain adjustment located on the encoder preamp board (20869-502-000). These adjustments require resetting when either the preamp board or the encoder/ servomotor assembly is replaced.

NOTE

A runaway condition of a servomotor motion is indicative of a bias out of adjustment.

The following procedure uses test points and potentiometers found on the encoder preamp board. Table 1-5 summarizes the bias and gain adjustments. The scope ac ground should be floating when making the following checks and adjustments.

Coarse Bias and Gain Adjustment

1. Connect the scope ground to TP9.
2. Connect the scope probe to the test point for the servomotor and the phase (see Table 1-5).
3. Remove any pen from the pen block to prevent pen damage.
4. Zero and center the scope trace; set volts/div to .5 volts.
5. Turn on the plotter and set the PLOT/STAND BY switch to STAND BY and the PLOT/LOAD switch to LOAD.
6. Move, by hand, the axis being adjusted, observe waveform, adjust gain for one volt peak to peak. Adjust bias so that the wave form is equally above and below the established zero reference.
7. Repeat step 6 for each phase of both servomotors.

Fine Bias and Gain Adjustment

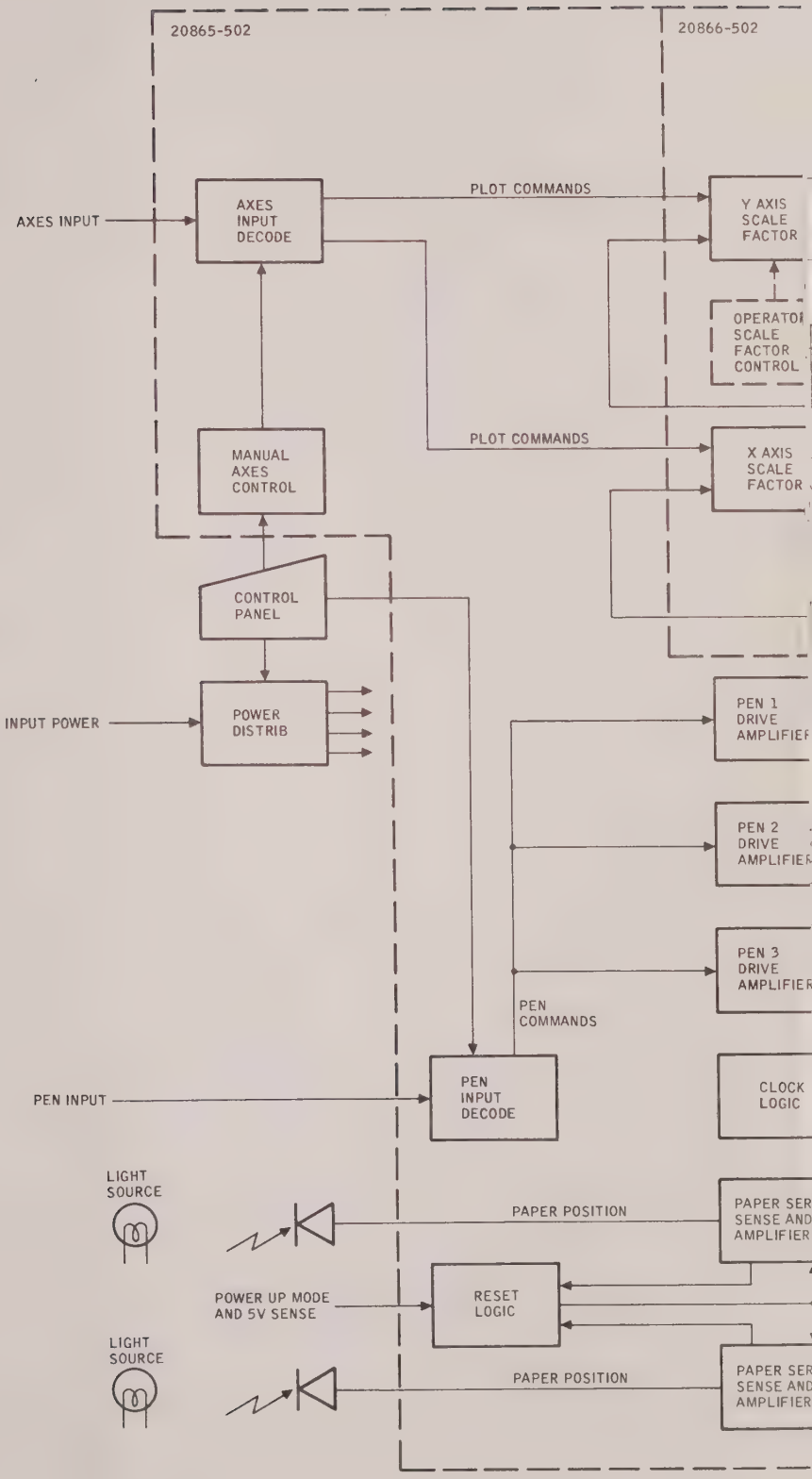
1. Install paper and set the PLOT/LOAD switch to PLOT.
2. Press and hold the appropriate manual control while observing the associated TP.
3. Adjust gain for one volt peak to peak.
4. Adjust bias so that the waveform is equally above and below the established zero reference.
5. Continue adjusting bias and gain of both servomotors and phases until all waveforms have a one volt peak to peak signal equally above and below the established zero reference while using the manual controls.

TABLE 1-5. ENCODER BIAS AND GAIN ADJUSTMENTS

Servomotor	Phase	Test Point	Bias Pot	Gain Pot
X axis	A	TP5	R6	R17
	B	TP6	R8	R18
Y axis	A	TP7	R10	R19
	B	TP8	R12	R20

SECTION 2

FUNCTIONAL DIAGRAMS


20865-502
20866-502
AXES INPUT
AXES INPUT DECODE
PLOT COMMANDS
Y AXIS SCALE FACTOR
OPERATOR SCALE FACTOR CONTROL
PLOT COMMANDS
X AXIS SCALE FACTOR
MANUAL AXES CONTROL
CONTROL PANEL
INPUT POWER
POWER DISTRIB
PEN 1 DRIVE AMPLIFIER
PEN 2 DRIVE AMPLIFIER
PEN 3 DRIVE AMPLIFIER
PEN COMMANDS
PEN INPUT
PEN INPUT DECODE
CLOCK LOGIC
LIGHT SOURCE
PAPER POSITION
PAPER SENSE AND AMPLIFIER
POWER UP MODE AND 5V SENSE
RESET LOGIC
LIGHT SOURCE
PAPER POSITION
PAPER SENSE AND AMPLIFIER

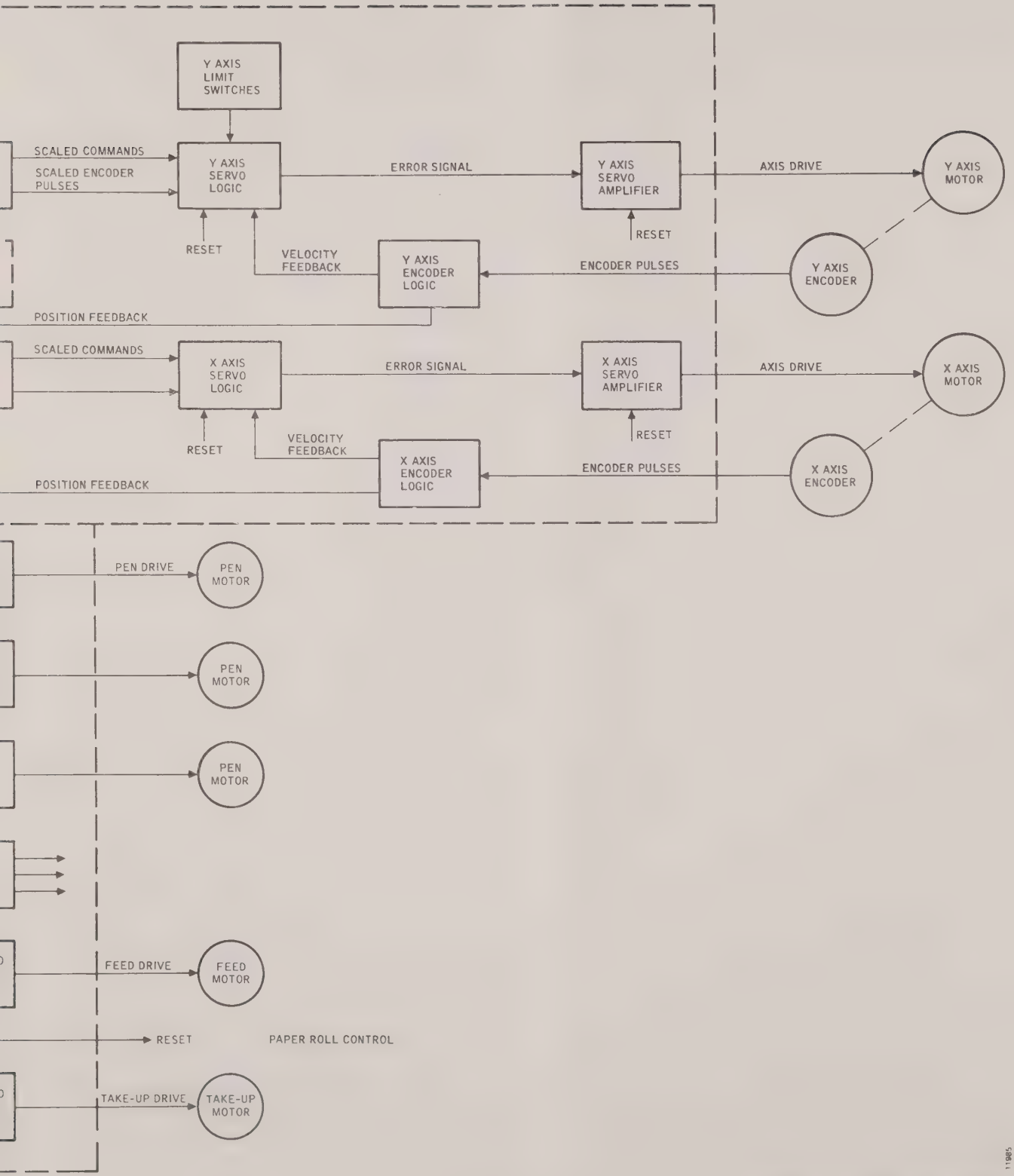
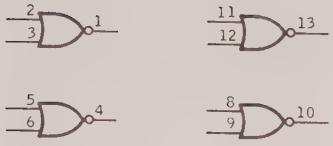
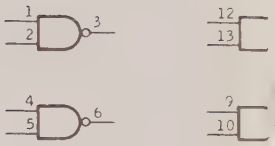


Figure 2-1. System Block Diagram



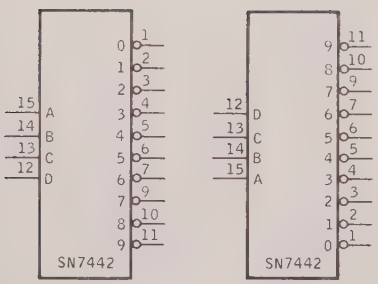
GRD - 7
V_{CC} - 14

SN7402
QUAD 2-INPUT NOR GATE



GRD - 7
V_{CC} - 14

SN7400
QUAD 2-INPUT NAND GATE

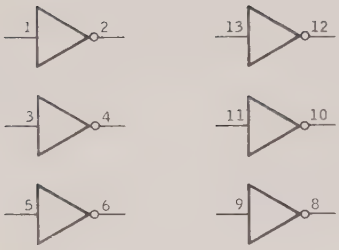


GRD - 8
V_{CC} - 16

BCD INPUT (MSB) (LSB) | DECIMAL OUTPUT

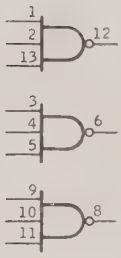
D	C	B	A	0	1	2	3	4	5	6	7	8
0	0	0	0	0	1	1	1	1	1	1	1	1
0	0	0	1	1	0	1	1	1	1	1	1	1
0	0	1	0	1	1	0	1	1	1	1	1	1
0	0	1	1	1	1	1	0	1	1	1	1	1
0	1	0	0	1	1	1	1	0	1	1	1	1
0	1	0	1	1	1	1	1	1	0	1	1	1
0	1	1	0	1	1	1	1	1	1	0	1	1
0	1	1	1	1	1	1	1	1	1	1	0	1
1	0	0	0	1	1	1	1	1	1	1	1	0
1	0	0	1	1	1	1	1	1	1	1	1	1
1	0	1	0	1	1	1	1	1	1	1	1	1
1	0	1	1	1	1	1	1	1	1	1	1	1
1	1	0	0	1	1	1	1	1	1	1	1	1
1	1	0	1	1	1	1	1	1	1	1	1	1
1	1	1	0	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1

SN7442
4-LINE TO 10-LINE DECODER



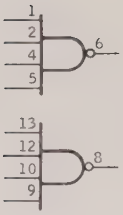
GRD - 7
V_{CC} - 14

SN7404
HEX INVERTER



GRD - 7
V_{CC} - 14

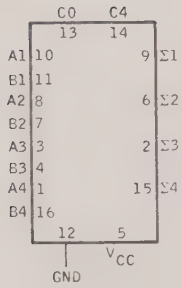
SN7410
TRIPLE 3-INPUT NAND GATE



GRD - 7
V_{CC} - 14
NC - 3,11

SN7420
DUAL 4-INPUT NAND GATE

7442



INPUT:

A1, A2, A3, A4	A FIELD BINARY INPUT
B1, B2, B3, B4	B FIELD BINARY INPUT
C0	CARRY INPUT

OUTPUT:

Σ1	C0 + A1 + B1
Σ2	(CARRY OUT OF Σ1) + A2 + B2
Σ3	(CARRY OUT OF Σ2 = C2) + A3 + B3
Σ4	(CARRY OUT OF Σ3) + A4 + B4
C4	CARRY OUT OF Σ4

FUNCTIONAL TABLE

INPUT				OUTPUT					
				C0 = L			C0 = H		
A1	B1	A2	B2	Σ1	Σ2	C2	Σ1	Σ2	C2
				C2 = L			C2 = H		
A3	B3	A4	B4	Σ3	Σ4	C4	Σ3	Σ4	C4
L	L	L	L	L	L	L	H	L	L
H	L	L	L	H	L	L	L	H	L
L	H	L	L	H	L	L	L	H	L
H	H	L	L	L	H	L	H	H	L
L	L	H	L	L	H	L	H	H	L
H	L	H	L	H	H	L	L	L	H
L	H	H	L	H	H	L	L	L	H
H	H	H	L	L	L	H	H	L	H
L	L	L	H	L	H	L	H	H	L
H	L	L	H	H	H	L	L	L	H
L	H	L	H	H	H	L	L	L	H
H	H	L	H	L	L	H	H	L	H
L	L	H	H	L	L	H	H	L	H
H	L	H	H	H	L	H	L	H	H
L	H	H	H	H	L	H	L	H	H
H	H	H	H	L	H	H	H	H	H

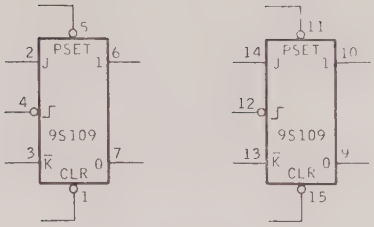
H = HIGH LEVEL, L = LOW LEVEL

NOTE:
INPUT CONDITIONS AT A1, B1, A2, B2, AND C0 ARE USED TO DETERMINE OUTPUTS Σ1 AND Σ2 AND THE VALUE OF THE INTERNAL CARRY C2. THE VALUES AT C2, A3, B3, A4, AND B4 ARE THEN USED TO DETERMINE OUTPUTS Σ3, Σ4, AND C4

74LS83A
4-BIT BINARY FULL ADDER WITH FAST CARRY

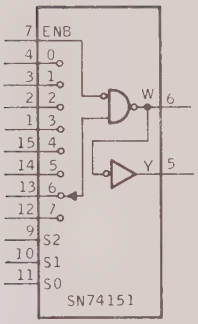
11978

Figure 2-2. Chip Description (Sheet 1)



V_{CC} - 16
GRD - 8

9S109
SN74LS109
DUAL J-$\overline{K}$ POSITIVE-EDGE-TRIGGERED
FLIP-FLOPS WITH PRESET AND CLEAR

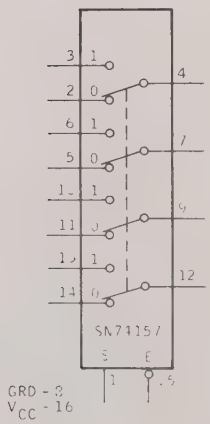


GRD - 8
V_{CC} - 16

INPUTS								
S2	S1	S0	ENB	0	1	2	3	4
X	X	X	H	X	X	X	X	X
L	L	L	L	L	X	X	X	X
L	L	L	L	H	X	X	X	X
L	L	H	L	X	L	X	X	X
L	L	H	L	X	H	X	X	X
L	H	L	L	X	X	L	X	X
L	H	L	L	X	X	H	X	X
L	H	H	L	X	X	X	L	X
L	H	H	L	X	X	X	H	X
H	L	L	L	X	X	X	X	L
H	L	L	L	X	X	X	X	H
H	L	H	L	X	X	X	X	X
H	H	L	L	X	X	X	X	X
H	H	L	L	X	X	X	X	X
H	H	H	L	X	X	X	X	X
H	H	H	L	X	X	X	X	X

H - HIGH LEVEL, L = LOW LEVEL, X -

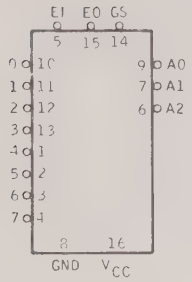
SN74151
DATA SELECTOR/MULTIPLEXER



GRD - 8
V_{CC} - 16

ENABLE	SELECT INPUT	INP
E	S	0
H	X	X
L	L	L
L	L	H
L	H	X
L	H	X

SN74157
QUAD 2-INPUT MULTIPLEXER



PUT:

0, 1, 2, 3, 4, 5, 6, 7	DATA INPUT
EI	ENABLE INPUT

TPUT:

A2, A1, A0	3-LINE BINARY OUTPUT
EO	ENABLE OUTPUT
GS	INDICATES WHEN ONE OR MORE INPUTS ARE ACTIVE

PUTS AND OUTPUTS ARE ACTIVE AT THE LOW LOGIC LEVEL

			OUTPUTS	
5	6	7	Y	W
X	X	X	L	H
X	X	X	L	H
X	X	X	H	L
X	X	X	L	H
X	X	X	H	L
X	X	X	L	H
X	X	X	H	L
X	X	X	L	H
X	X	X	H	L
X	X	X	L	H
X	X	X	H	L
L	X	X	L	H
H	X	X	H	L
X	L	X	L	H
X	H	X	H	L
X	X	L	L	H
X	X	H	H	L

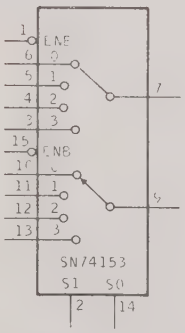
RELEVANT

TS	OUTPUT
1	
X	L
X	L
	H
–	L
H	H

74LS148
ENCODER 8 DATA LINES TO 3-LINE BINARY (OCTAL)

FUNCTION TABLE													
INPUTS									OUTPUTS				
EI	0	1	2	3	4	5	6	7	A2	A1	A0	GS	EO
H	X	X	X	X	X	X	X	X	H	H	H	H	H
L	H	H	H	H	H	H	H	H	H	H	H	H	L
L	X	X	X	X	X	X	X	L	L	L	L	L	H
L	X	X	X	X	X	X	L	H	L	L	H	L	H
L	X	X	X	X	X	L	H	H	L	H	L	L	H
L	X	X	X	X	L	H	H	H	L	H	H	L	H
L	X	X	X	L	H	H	H	H	H	L	L	L	H
L	X	X	L	H	H	H	H	H	H	L	H	L	H
L	X	L	H	H	H	H	H	H	H	H	L	L	H
L	L	H	H	H	H	H	H	H	H	H	H	L	H

H = HIGH LOGIC LEVEL
L = LOW LOGIC LEVEL
X = IRRELEVANT



GRD - 8
V_{CC} - 16

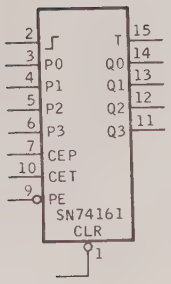
SELECT INPUTS		DATA INPUTS				ENABLE	OUTPUT
S1	S0	0	1	2	3		
X	X	X	X	X	X	H	L
L	L	L	X	X	X	L	L
L	L	H	X	X	X	L	H
L	H	X	L	X	X	L	L
L	H	X	H	X	X	L	H
H	L	X	X	L	X	L	L
H	L	X	X	H	X	L	H
H	H	X	X	X	L	L	L
H	H	X	X	X	H	L	H

ADDRESS INPUTS S0 AND S1 ARE COMMON TO BOTH SECTIONS.
H HIGH LEVEL, L LOW LEVEL, X IRRELEVANT

SN74153
DUAL 4-LINE-TO-1-LINE DATA SELECTOR MULTIPLEXER

11379

Figure 2-2. Chip Description (Sheet 2)



PARALLEL ENABLE (PE LOW)
P0→Q0
P1→Q1
P2→Q2
P3→Q3
OUTPUTS AFTER FIRST CLOCK

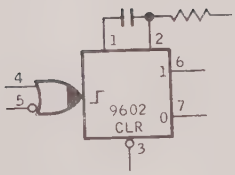
COUNT 0→15 = CET•CEP

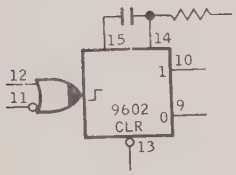
INHIBIT COUNT = CET/ + CEP/

CARRY OUTPUT
T = CET•COUNT 15

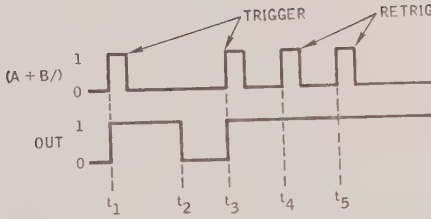
GRD - 8
V_{CC} - 16

SN74161
BINARY COUNTER





GRD - 8
V_{CC} - 16

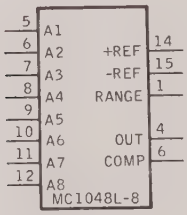


PIN 4 = A
PIN 5 = B
PIN 6 = OUT

TIMEOUT = $t_2 - t_1$
= $t_6 - t_5$
= 0.35C (R+0.85) FOR C >

WHERE R IS IN OHMS
C IS IN FARADS
TIMEOUT IS IN SECONDS

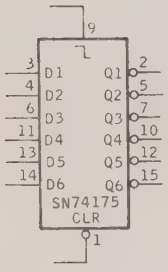
9602
DUAL RETRIGGERABLE ONE-S



GRD - 2
V_{EE} - 3
V_{CC} - 13

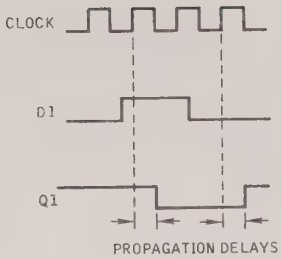
DIGITAL INPUTS								ANALOG OUTPUT MA
A1 MSB	A2	A3	A4	A5	A6	A7	A8 LSB	
0	0	0	0	0	0	0	0	0.0
1	1	1	1	1	1	1	1	-2.0

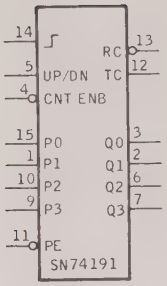
MC1408L-8
DIGITAL-TO-ANALOG CONVERTER



GRD - 8
V_{CC} - 16

SN74175
HEX D-TYPE FLIP-FLOP





GRD - 8
V_{CC} - 16

PARALLEL ENABLE (PE LOW)
P0 → Q0
P1 → Q1
P2 → Q2
P3 → Q3

ENABLE (CNT ENB)
HIGH - COUNT LOGIC DISABLED
LOW - COUNT ADVANCES ONE COUNT WITH EACH CLOCK RECEIVED

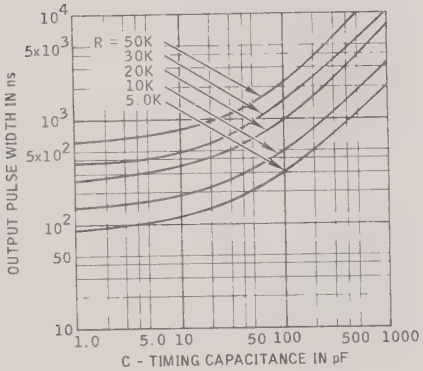
RC = [CLOCK • (COUNT 0 + COUNT 15)]

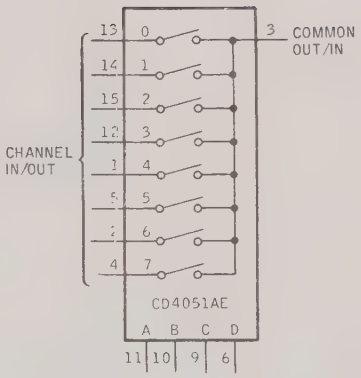
TC = COUNT 0 + COUNT 15

UP/DOWN
HIGH - COUNT DOWN
LOW - COUNT UP

SN74191
BINARY UP/DOWN COUNTER

OUTPUT PULSE WIDTH VERSUS TIMING RESISTANCE AND CAPACITANCE FOR C < 10^3 pF



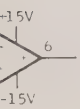


V_{EE} - 7
V_{SS} - 8
V_{DD} - 16

SELECT INPUTS
C(MSB) A(LSB) D(INHIBIT)

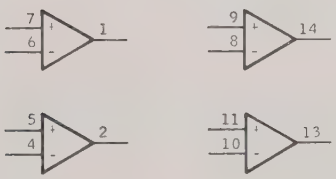
INPUT STATES				CHANNEL ON
D	C	B	A	
1	X	X	X	NONE
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7

CD4051AE
DIGITAL CONTROLLED
ANALOG MULTIPLEXER



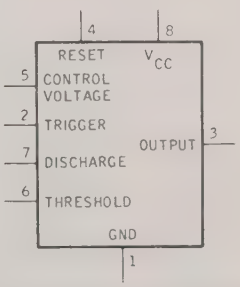
INPUT		OUTPUT
+	−	
H	L	H
L	H	L

709C OPERATIONAL AMPLIFIER (8 PIN)
741C OPERATIONAL AMPLIFIER (8 PIN)
748C OPERATIONAL AMPLIFIER (8 PIN)



GND - 12
V_{CC} - 3

MC3302P
QUAD COMPARATOR

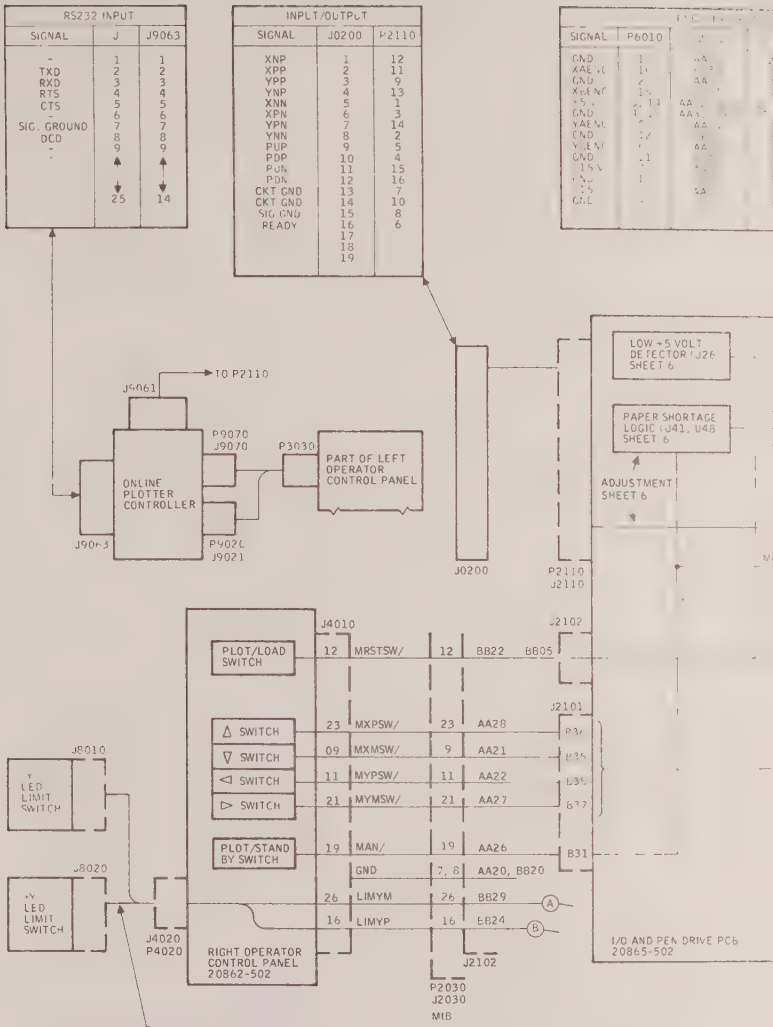


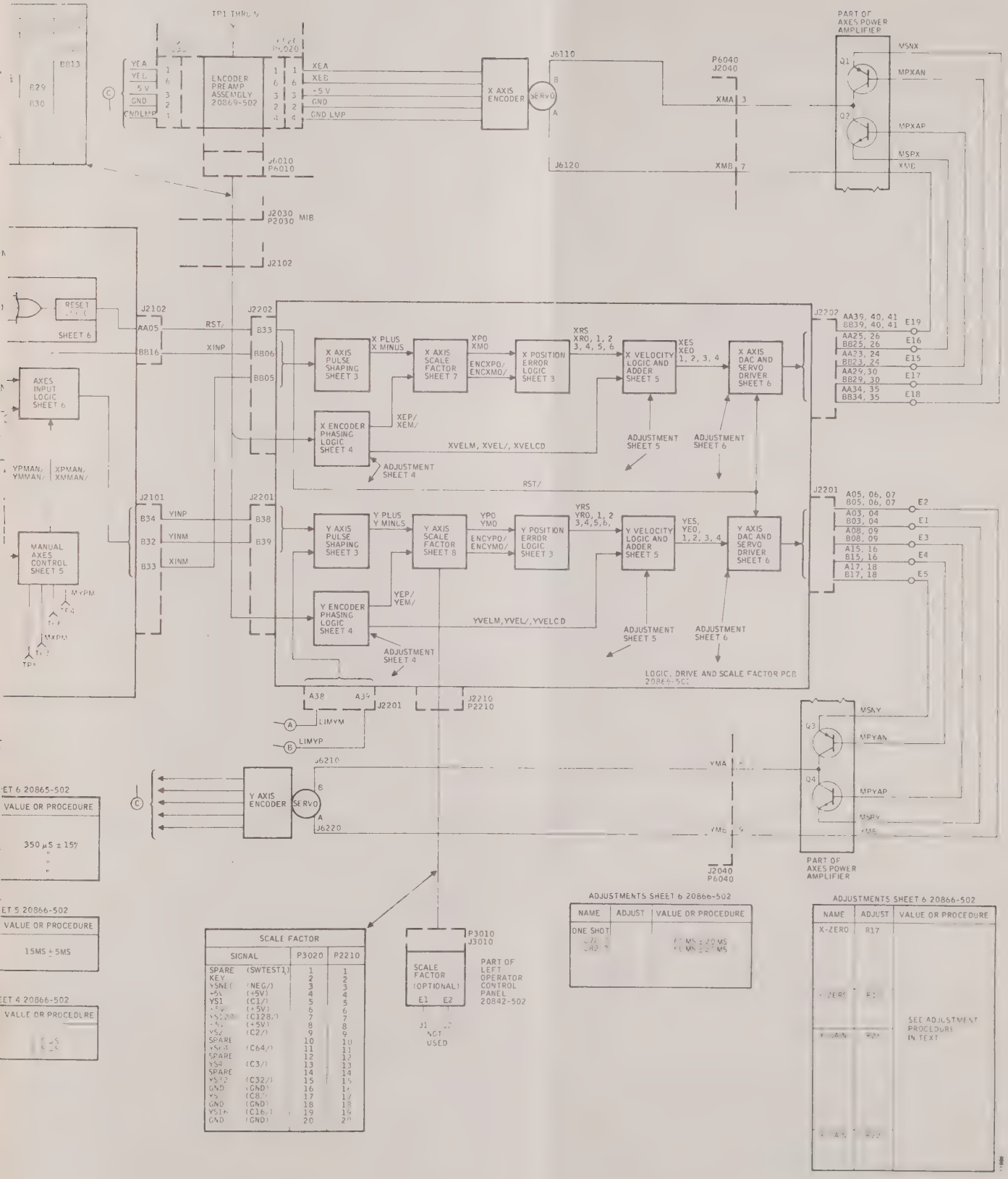
TRIGGERS AND RESETS ON TRAINING EDGE

NE555
TIMER USED FOR OSCILLATOR OR TIME DELAY

11980

Figure 2-2. Chip Description (Sheet 3)


RS232 INPUT
SIGNAL
J
J9063
TXD
RXD
RTS
CTS
SIG. GROUND
DCD
25
14
INPUT/OUTPUT
SIGNAL
J0200
P2110
XNP
XPP
YPP
YNP
XNN
XPN
YPN
YNN
PUP
PDP
PON
PDN
CKT GND
SIG GND
READY
SIGNAL
P6010
TO P2110
J9061
P9070
J9070
P3030
ONLINE PLOTTER CONTROLLER
PART OF LEFT OPERATOR CONTROL PANEL
J9063
P9020
J9021
J0200
P2110
J2110
LOW +5 VOLT DETECTOR U26 SHEET 6
PAPER SHORTAGE LOGIC (U41, U48 SHEET 6
ADJUSTMENT SHEET 6
J4010
J2102
PLOT/LOAD SWITCH
12
MRSTSW/
12
BB22
BB05
J2101
SWITCH
23
MXPSW/
23
AA28
SWITCH
09
MXMSW/
9
AA21
SWITCH
11
MYPSW/
11
AA22
SWITCH
21
MYMSW/
21
AA27
PLOT/STAND BY SWITCH
19
MAN/
19
AA26
B31
GND
7, 8
AA20, BB20
26
LIMYM
26
BB29
16
LIMYP
16
BB24
J8010
Y LED LIMIT SWITCH
J8020
-Y LED LIMIT SWITCH
J4020
P4020
RIGHT OPERATOR CONTROL PANEL 20862-502
J2102
P2030
J2030
MIB
I/O AND PEN DRIVE PCB 20865-502
Y LIMIT SWITCHES
SIGNAL
J4020
J8010
J8020
COLOR
+5 V
LIMYP
GND
GND
+5 V
LIMYM
GND
GND
BRN
RED
ORG
YEL
GRN
BLU
VIO
GRY
ADJUSTMENTS SH
NAME
ADJUST
DATA RATE ONE SHOTS
U12-10
U12-6
U11-10
U11-6
ADJUSTMENTS SH
NAME
ADJUST
ONE SHOT
U78 10
ADJUSTMENTS S
NAME
ONE SHOT
U19-7
U19-9
TEST POINTS
LOCATION
NUMBER
COLOR
VALUE
MANUAL AXES CONT (SHEET 5)
TP3
4
5
6
ENCODER PREAMP ASSEMBLY
TP1
2
3
4
5
6
7
8
GND
RED
ORG
YEL
GRN
BLU
VIO
GRAY
BLK

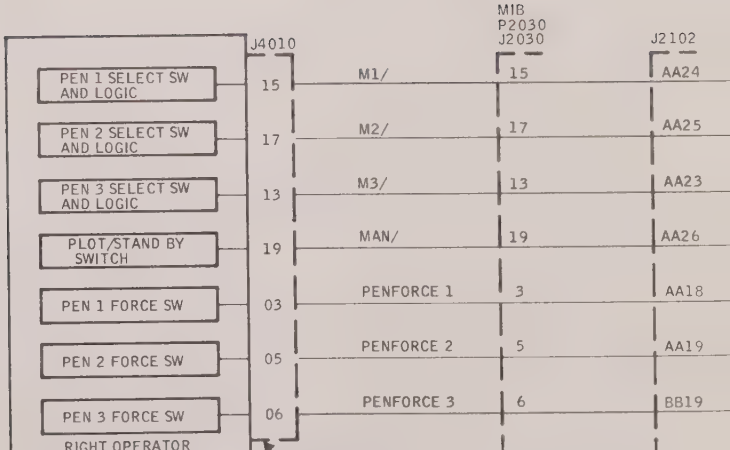


FD1. Axis Control Function Diagram

NAME
ONE SHOT
U40-7
U40-9
U39-6
U39-10

INPUT/OUTPUT		
SIGNAL	J0200	P2110
XNP	1	12
XPP	2	11
YPP	3	9
YNP	4	13
XNN	5	1
XPN	6	3
YPN	7	14
YNN	8	2
PUP	9	5
PDP	10	4
PUN	11	15
PDN	12	16
CKT GND	13	7
CKT GND	14	10
SIG GND	15	8
READY	16	6
	17	
	18	
	19	

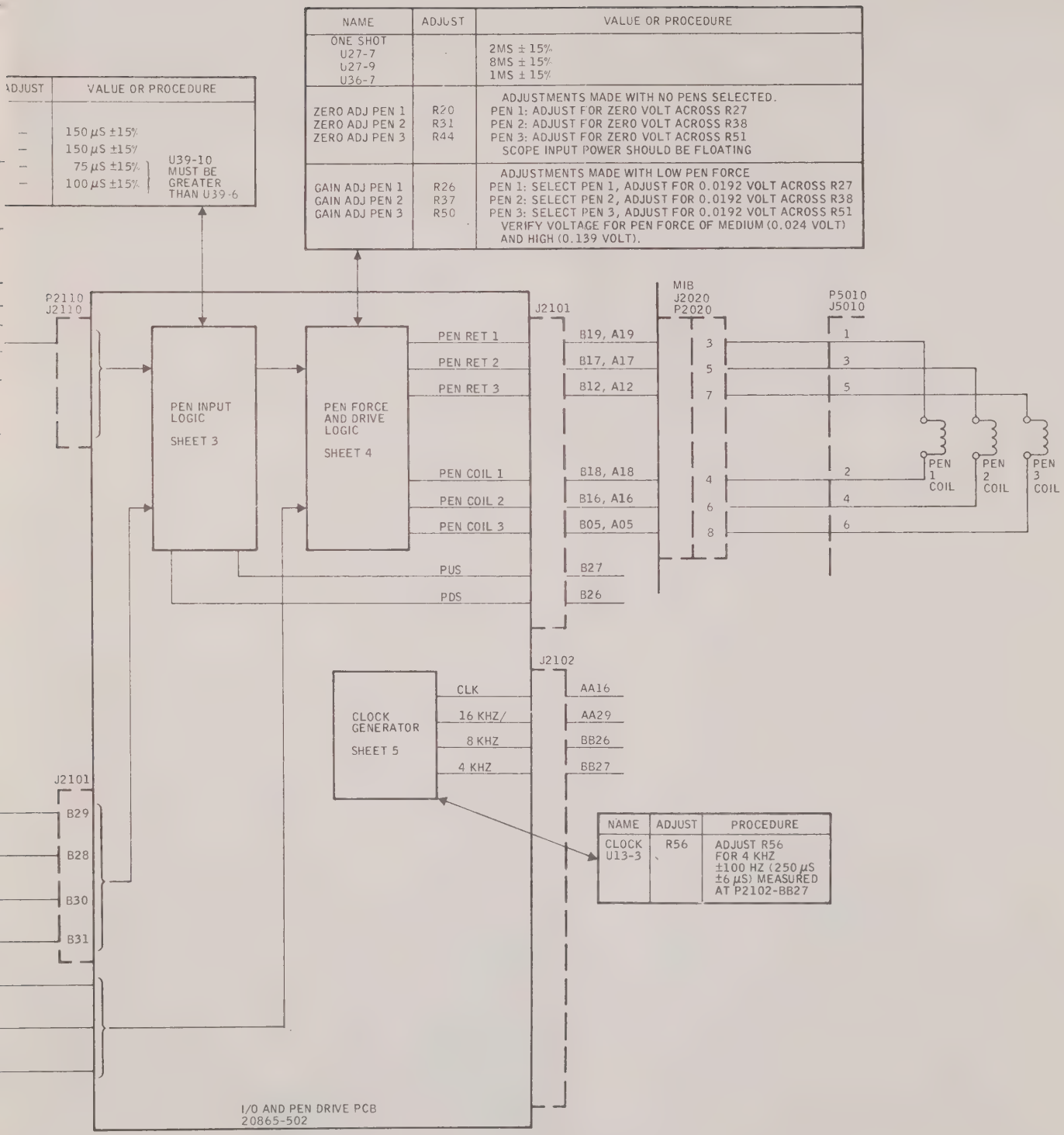
J0200



MODE SWITCH IN STAND BY *

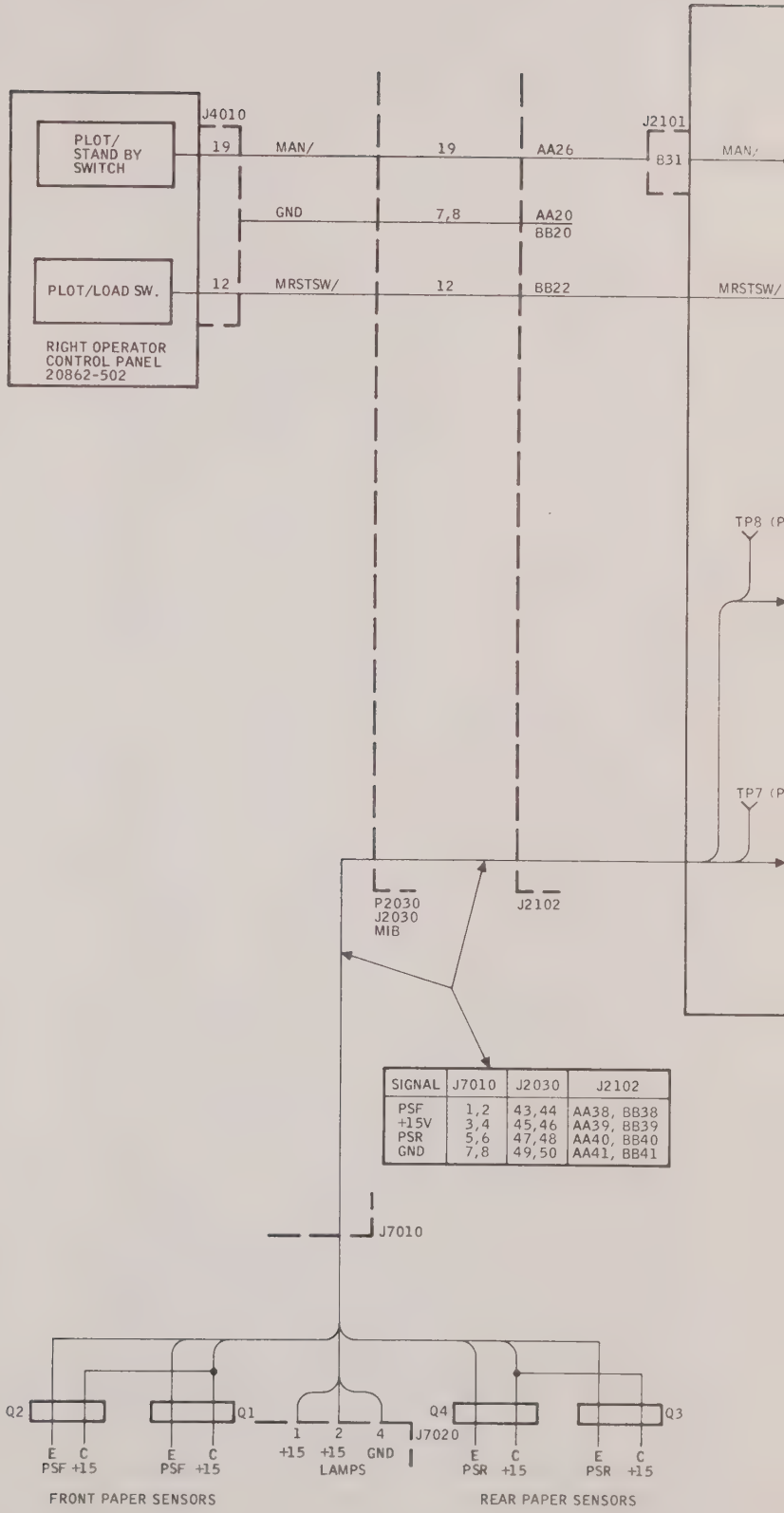
SWITCH	M1/	M2/	M3/	MAN/
PEN SELECT 1	L	H	H	L
PEN SELECT 2	H	L	H	L
PEN SELECT 3	H	H	L	L

*MODE SWITCH IN PLOT: M1/, M2/, M3/, AND MAN/ ARE HIGH

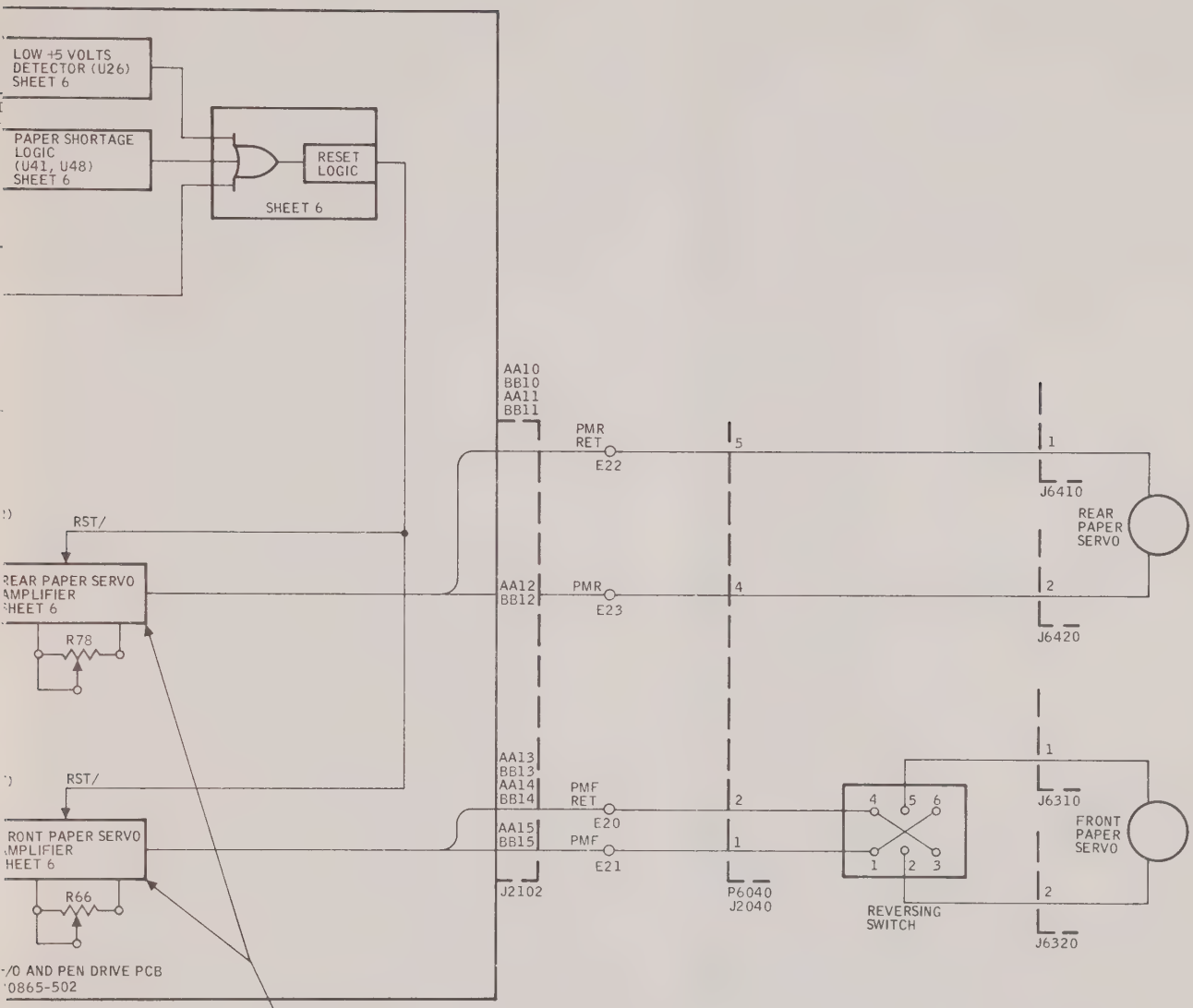


11987A

FD2. Pen Drive Functional Diagram



SIGNAL	J7010	J2030	J2102
PSF	1,2	43,44	AA38, BB38
+15V	3,4	45,46	AA39, BB39
PSR	5,6	47,48	AA40, BB40
GND	7,8	49,50	AA41, BB41



ADJUSTMENTS SHEET 6 20865-502

NAME	ADJUST	VALUE OR PROCEDURE
PMR (PAPER MOTOR REAR)	R78	ADJUST R78 WITH REAR PAPER SENSORS IN FULL LIGHT. TP8 = 9 ±0.25 VOLTS
PMF (PAPER MOTOR FRONT)	R66	ADJUST R66 WITH FRONT PAPER SENSORS IN FULL LIGHT. TP7 = 9 ±0.25 VOLTS.

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FD3. Paper Servo Functional Diagram

SECTION 3

THEORY OF OPERATION

500 SERIES INTERFACE (UNENCODED FORMAT)

The plotter interface consists of six input lines, two for X (for +X and -X movement), two for Y (for +Y and -Y movement) and two for Z (for pen up and pen down). No clock or strobe accompanies the data input. Activation of an X and Y input line together produces a diagonal movement. Activation of the two Z lines together causes entry into or exit from the pen select mode.

The TTL/HL signal level switch on the Data I/O and Pen Driver board selects one of two possible voltage levels for the input data pulse (see Figures 3-1 and 3-2). In addition, the plotter will accept positive-going pulses or negative-going pulses. The six data lines that accept positive-going pulses are identified by a three-letter mnemonic ending in P. The six data lines that accept negative-going pulses end in N. Tables 3-1 and 3-2 identify the two groups of interface signals.

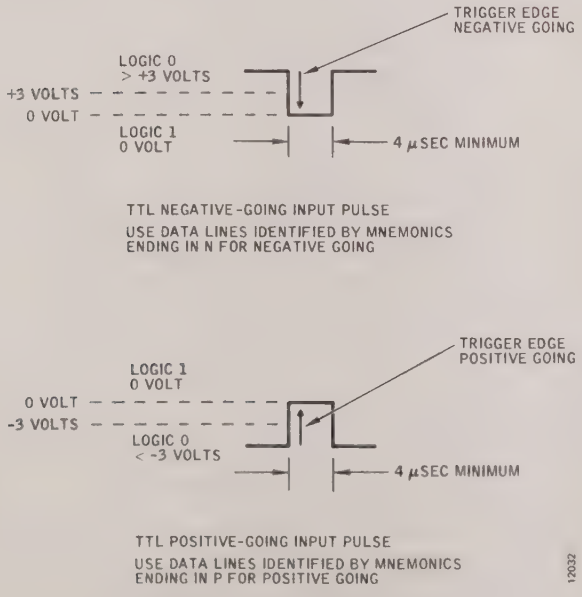

Figure 3-1. TTL Data Transmission

Pulses received on the data lines must have a pulse width greater than 4 microseconds. The pulse rise time must be less than 10 microseconds. The data rate for the plotter is 2250 pulses per second maximum (0.44 millisecond minimum period). The source impedance should be 500 ohms or less.

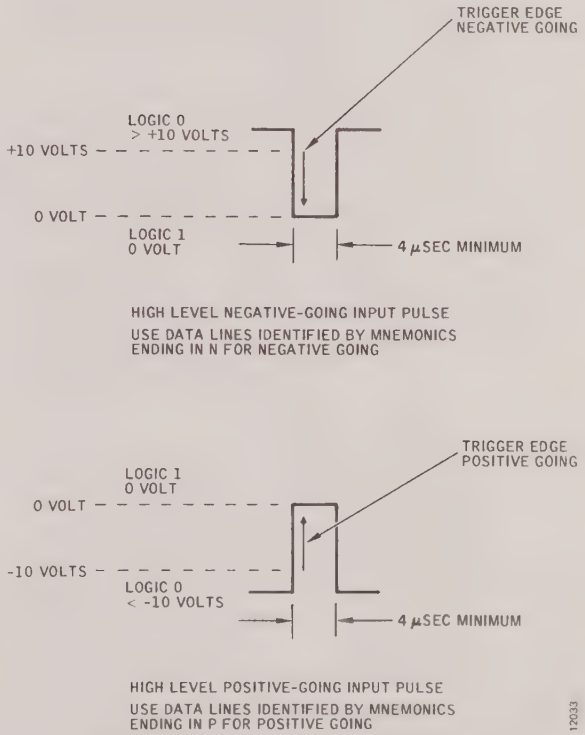

Figure 3-2. High Level Data Transmission

936 INTERFACE (PARALLEL ENCODED FORMAT)

A 1039 plotter equipped with the 936 interface option allows the plotter to use the same interface as the CalComp Model 936 digital drum plotter. Data is presented to the plotter as hexadecimal coded commands with a strobe pulse. Return signals from the plotter consist of a data request and plotter status (ready). Table 3-3 describes the input commands and codes. Table 3-4 lists the input/output connections. The command description is as follows:

- +X, -X, +Y, -Y: Designates incremental movement of drum (X) or pen carriage (Y) upon receipt of correponding code. Each increment of movement requires a command.

TABLE 3-1. FUNCTION OF INPUT SIGNALS

Positive-Going Input*	Negative-Going Input**	Funtion (First Two Letters of Mnemonic)
XPP	XPN	X axis movement in positive direction
XNP	XNN	X axis movement in negative direction
YPP	YPN	Y axis movement in positive direction
YNP	YNN	Y axis movement in negative direction
PUP	PUN	Pen up
PDP	PDN	Pen down

*Mnemonics for positive-going input pulse end in P.
**Mnemonics for negative-going input pluse end in N.

TABLE 3-2. PLOTTER INPUT CONNECTOR

Pin No.	Signal
1	XNP
2	XPP
3	YPP
4	YNP
5	XNN
6	XPN
7	YPN
8	YNN
9	PUP
10	PDP
11	PUN
12	PDN
13	External Gnd (Floating)
14	Chassis Gnd
15	Chassis Gnd (Signal)
16	-15 Volts (Ready)
17	No Connection
18	No Connection
19	No Connection

TABLE 3-3. INPUT FORMAT COMMANDS

Hex Code	Binary C4	C3	C2	C1	Command
0	0	0	0	0	+Y
1	0	0	0	1	+Y, +X
2	0	0	1	1	+X
3	0	0	1	1	-Y, +X
4	0	1	0	0	-Y
5	0	1	0	1	-Y, -X
6	0	1	1	0	-X
7	0	1	1	1	+Y, -X
8	1	0	0	0	Enter Special Function Mode
9	1	0	0	1	Pen Up
A	1	0	1	0	Pen Down
B	1	0	1	1	No Operation
C	1	1	0	0	Not Used
D	1	1	0	1	Not Used
E	1	1	1	0	Leave Special Function Mode
F	1	1	1	1	Not Used
8	1	0	0	0	Select PEN 1
9	1	0	0	1	
E	1	1	1	0	
8	1	0	0	0	Select PEN 2
9	1	0	0	1	
9	1	0	0	1	
E	1	1	1	0	
8	1	0	0	0	Select PEN 3
9	1	0	0	1	
9	1	0	0	1	
9	1	0	0	1	
E	1	1	1	0	

TABLE 3-4. INPUT/OUTPUT SIGNAL TERMINATION ELCO CONNECTOR*

Terminal	Signal	
A	XC1	Twisted pair
B	XC1'	Binary encoded input
C	XC2	Twisted pair
D	XC2'	Binary encoded input
E	XC3	Twisted pair
F	XC3'	Binary encoded input
H	XC4	Twisted pair
J	XC4'	Binary encoded input
N	XCS	Twisted pair
P	XCS'	STROBE
R	XPR	Twisted pair
S	XPR'	PLOT REQUEST
c	RDY	Ready
e	GRD	Ground
f	GRD	Ground

*ELCO connector at plotter is P/N 00-8016-056-000-702
ELCO mating connector is P/N 00-8016-056-000-723

- Enter Special Function: Permits subdivision of function or routine such as pen selection.
- Pen Up: Command interpreted to cause pen to be raised from plotting surface.
- Pen Down: Command interpreted to cause pen to be lowered to plotting surface.
- Leave Special Function: Permits exiting the special mode previously entered.
- No Operation or Not Used: Commands are not recognized and should be used for time-out or delay functions.

PAPER DRIVE SERVO

Paper drive servos are used to maintain the isolation loops between the drum and the paper feed spool and between the drum and the takeup spool. The paper drive servo is fully analog in operation (see schematic diagram 20865-502-000, sheet 6 in Model 1039 Engineering Drawings manual, P/N 10219-901-009 and functional flow diagram FD3 in this volume). The front and rear paper servos have identical circuits but with different component designations. Only the front paper servo and its designations will be discussed.

Front paper servo amplifier U49 receives positive feedback from two, parallel-connected light-sensitive transistors (Q1 and Q2) located at the front of the paper pan. The transistors are emitter-coupled to the voltage divider (R66, R67, and R68) where positive feedback may be adjusted by R66.

Negative feedback is obtained from front paper motor signal PMF through sense resistor R75. When the paper loop at the front of the paper pan is too small and the light source fully illuminates the transistors, a positive error voltage is generated at the output of the servo amplifier. This positive voltage causes the front paper motor to push more paper into the pan. When the paper loop is large enought, the light source is partially interrupted reducing the error voltage to zero. If too much paper is fed into the pan, the light source is completely cut off. A negative error voltage is generated at the output of the servo amplifier. This negative error voltage causes the front paper motor to pull paper from the pan. Equilibrium is reached when the light-sensitive transistors are partially exposed to the light source.

If the light-sensitive transistors are fully exposed to the light source for more than 3 seconds, an out-of-paper condition is assumed. Reset signal RST/ goes low and energizes relay K3, which disconnects the drive to both paper servomotors. RST/ also energizes relays K1 and K2, which remove the holddown current from the pen coil and allow the spring-loaded pen to retract. Energized relays K1 and K2 also remove the drive current from the X and Y servos. The out-of-paper condition is ignored if the PLOT/STAND BY switch is in the STAND BY position. The STAND BY position causes MAN/ (manual) to go low, which holds the comparator U48 pin 13 output high and prevents U48 pin 14 from responding to the paper servo amplifier. With the PLOT/STAND BY switch in the PLOT position, the comparator U48 pin 14 output goes low whenever the servo amplifier U49 output is high for more than 3 seconds. Chip U25 responds to this out-of-paper condition by a low level output on RST/. The PLOT/LOAD switch in the LOAD position causes MRSTSW/ to go low, causing U25 to respond with no time delay by a low-level output on RST/.

PEN CONTROL

Pen control interface lines PUP and PDP (Pen Up Positive, Pen Down Positive) are used when the input signals are positive-going pulses. Interface lines PUN and PDN (Pen Up

Negative, Pen Down Negative) are used when the input signals are negative-going pulses. In the following discussion, PUP and PDP are used.

Pen Select Mode

Any of the three pens may be selected by using the PUP and PDP interface lines. Pulses received on PUP and PDP at the same time place the pen circuit in the pen select mode. One, two, or three pulses received on PUP selects pen one, pen two, or pen three respectively. Pulses again received at the same time on PUP and PDP cause the pen circuit to leave the pen select mode. A PDP pulse will now lower the selected pen.

Circuit Description

Refer to schematic 20865-502-000, sheets 3 and 4 while reading the following description. When PUP and PDP receive pulses at the same time, AND gate output PUDS/ goes low (sheet 3). Flip-flop PSFF is set via its clock input, causing the pen circuit to enter the pen select mode. The two-bit counter (PSF1 and PSF2) is enabled and is stepped by pulses received on the pen up (PUP) line. Pen 1 is selected for PSF1 + PSF2/, pen 2 is selected for PSF1/ + PSF2, pen 3 is selected for PSF1 + PSF2.

With the desired pen selection held in PSF1 and PSF2, the pen select mode must be left before processing other commands. To leave the pen select mode, PUP and PDP are again pulsed at the same time. AND gate output PUDS/ goes low and toggles flip-flop PSFF to its reset state. The two-bit counter (PSF1 and PSF2) is inhibited from further change while PSFF is low.

While flip-flop PSFF is high, indicating the pen select mode, multiplexers S2 and S3 (sheet 4) are inhibited and prevent access to the pen amplifiers. With PSFF low, multiplexer S3 selects the pen amplifier determined by the two-bit counter (PSF1 and PSF2). No further action takes place until a pen down pulse is received.

A pen down pulse on PDP produces a pulse at the output of flip-flop PDS (sheet 3). Flip-Flop PDS sets flip-flop PF, which was reset during the pen select mode. When flip-flop PF is set, PSDN goes high. PSDN sequences the pen current to the pen amplifier by using multiplexer S2.

When PSDN goes high, one-shot PT1 fires for 2 milliseconds, followed by one-shot PT2 firing for 8 milliseconds. While PT1/ is low, multiplexer S2 selects input binary 1 (pin 14), which produces an initial loading current. While PT2/ is low, multiplexer S2 selects input binary 2 (pin 15), which produces a reduced pen current during pen travel to the paper. When PT2/ goes high, multiplexer S2 selects PENFORCE1, PENFORCE2, or PENFORCE3 depending on which pen is selected. To raise the pen, a pen up command is sent; this command resets flip-flop PF, causing PSDN to go low. One-shot PT3/ then fires, and PT3/ selects binary 3 (pin 12) of S2, which produces a negative current to raise the pen. Figure 3-3 shows the current pattern for lowering and raising a pen.

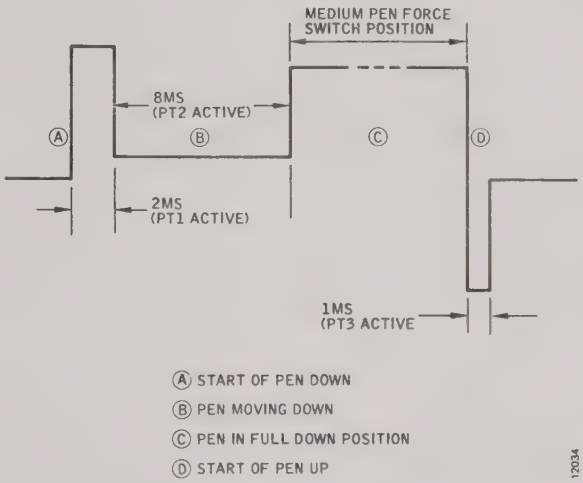

Figure 3-3. Pen Current Pattern

Axis Drive Servo

The axis drive servo uses both analog and digital feedback loops (see Figure 3-4). A signal developed across the sense resistor (analog) is used to stabilize the gain of the dc amplifier, and the output of the encoder (digital) is used as position and velocity feedback. See schematic 20866-502-000, sheet 6.

The count in the error register is increased (in either the positive or the negative direction) by the plot motion pulses and is decreased (in either the negative or the positive direction) by the encoder counts. Note that positive plotting motion is caused by positive plot commands and results in negative encoder counts.

Four velocity pulses are produced for each encoder count. These pulses are accumulated in the velocity counter, and the total count is transferred to the velocity register every 250 microseconds (4 kHz period). A delay circuit is used so that the transfer is not made while a velocity pulse is being clocked into the counter. (This same delay prevents clocking a plot motion command pulse into the error register while an encoder count is being received.) The velocity counter is reset to zero after each transfer of the count.

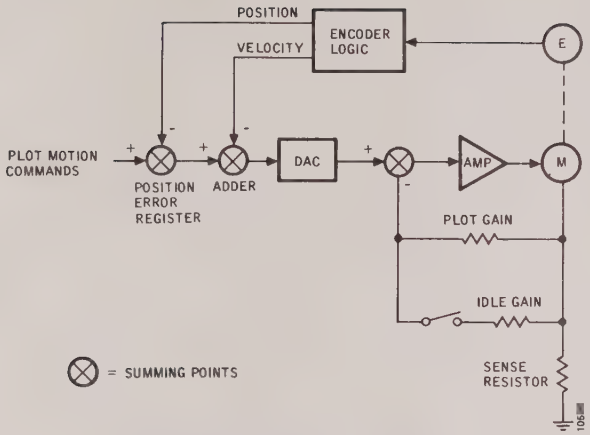

Figure 3-4. Axis Servo Diagram

A high-gain servo loop has a tendency to hunt while receiving signals. To prevent this hunting in the X and Y servos, gain is reduced whenever plot motion commands are not received for more than 60 ±20 milliseconds. This gain reduction is accomplished by increasing the feedback on a dc amplifier (U76 for the X axis and U70 for the Y axis). As long as one-shot U82 (for the X axis) or U78 (for the Y axis) receives plot motion commands, resistor R34 (for the X axis) or R35 (for the Y axis) is removed from the feedback loop and the amplifier gain is high.

SECTION 4

ILLUSTRATED PARTS BREAKDOWN

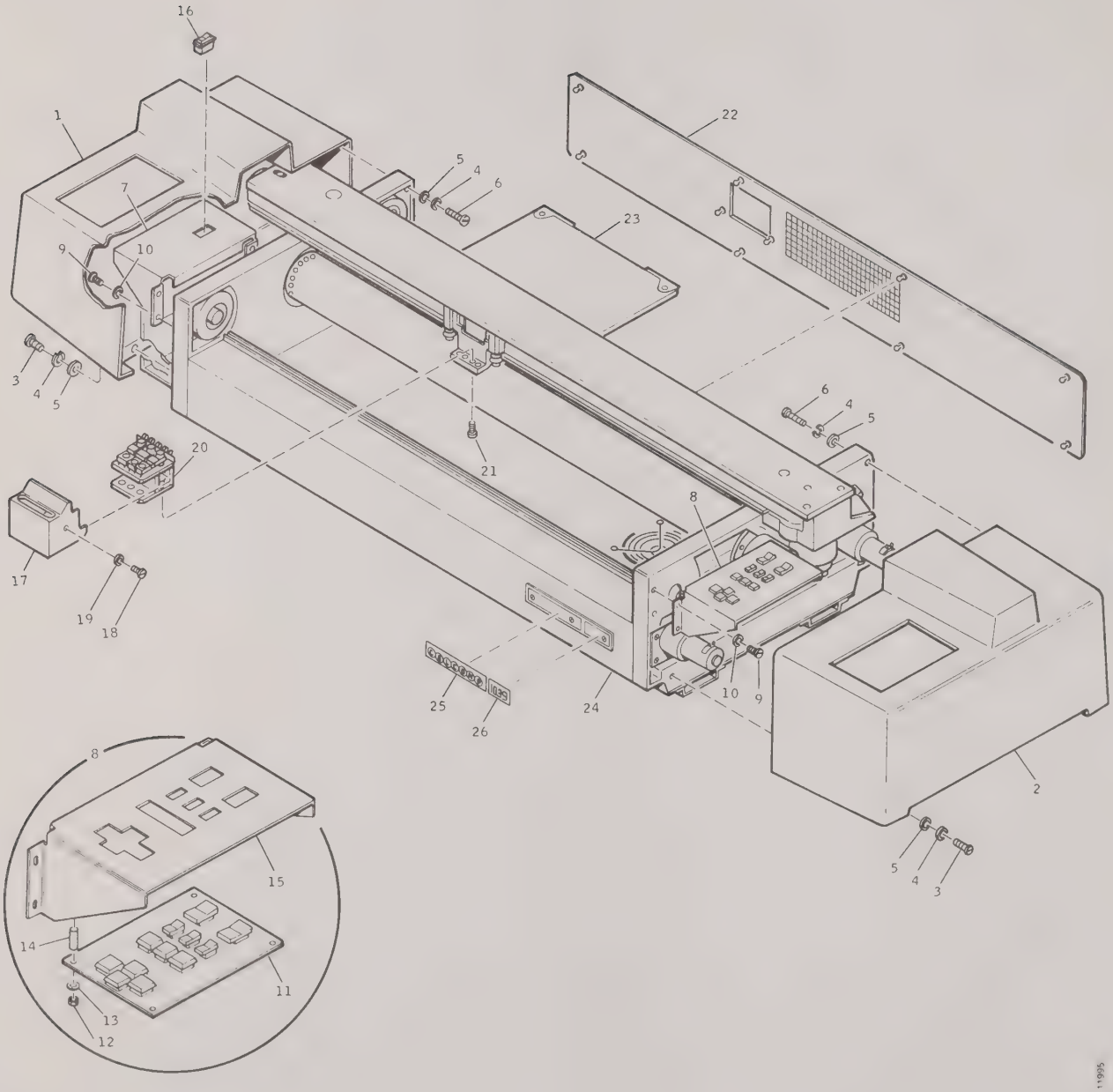

Figure 4-1. Model 1039 Plotter Unit

Figure/ Item No.	I.C. Number	Part Number	Description	Qty. Per Assy.
1-	442180-6	20208-101-000	Plotter Unit, Model 1039	REF
-1	442150-9	10157-210-001	. Endbell, Plotter, LH	1
-2	442160-8	10157-210-002	. Endbell, Plotter, RH	1
			Attaching Parts	
-3	029730-9	60010-206-291	. Screw, Pan Hd, 8-32 x 3/8 Lg.	6
-4	030080-6	74007-206-141	. Lockwasher, Split	10
-5	171750-3	74002-206-141	. Washer, Flat	10
-6	153050-0	60010-206-298	. Screw, Pan Hd. 8-32 x 1.25 Lg.	4
			---*---	
-7	442110-3	21721-203-000	. Bracket, Control Panel LH	1
-8	442190-5	10516-310-000	. Panel Assy, Plotter, RH	1
			Attaching Parts (above two items	
-9	029730-9	60010-206-291	. Screw, Pan Hd, 8-32 x 3/8 Lg.	8
-10	030080-6	74007-206-141	. Lockwasher, Split	8
			---*---	
-11	442740-7	20862-502-000	. . Board Assy, Control Panel	1
			Attaching Parts	
-12	050590-9	50001-206-012	. . Nut, Hexagon	4
-13	030010-3	74008-206-111	. . Lockwasher, Internal Tooth	4
-14	445130-8	72010-206-022	. . Spacer	4
			---*---	
	438260-2	10429-304-001	. . . Switch, Sp, 2, 3, 6, 7, 9, N/I	7
	444030-1	10023-304-001	. . . Switch, S4, 5, N/I	2
	444020-2	10022-304-001	. . . Switch, S11, 12, 13, N/I	3
-15	442200-2	21690-203-000	. . Panel, Control	1
-16	397740-2	10017-304-001	. Switch, Red	1
-17	441990-9	10163-210-005	. Cover, Pen Block	1
			Attaching Parts	
-18	029500-6	60010-206-165	. Screw, Pan Hd. 4-40 x 1/4 Lg.	2
-19	149140-6	74002-206-071	. Washer, Flat	2
			---*---	
-20		30006-905-000	. Pen Block Assy, Plotter, 3 Pen	1
			Attaching Parts	
-21	299920-9	60028-206-291	. Screw, Socket Hd. Cap, 8-32 x 3/8 Lg.	2
			---*---	
	187230-8	11143-204-000	. Plate, Identification, N/I	1
	187350-4	11142-204-000	. Nameplate, N/I	1
-22	442100-4	21485-203-100	. Panel, Rear	1
-23	441950-3	20865-502-000	. Board Assy, I/O Driver	1
-24	440590-8	10529-310-000	. Plot Head Assy, Plotter	1
			(refer to Figure 3-2 for components)	
-25	273950-6	10016-213-003	. Logo, CALCOMP	1
-26	430860-7	10016-213-087	. Logo, 1039	1
	397130-6	20528-401-000	. Ac Power Cable Domestic	REF
	407300-3	20544-401-000	. Ac Power Cable Export	REF
	063250-5	10021-404-000	. Signal Cable Connector	REF

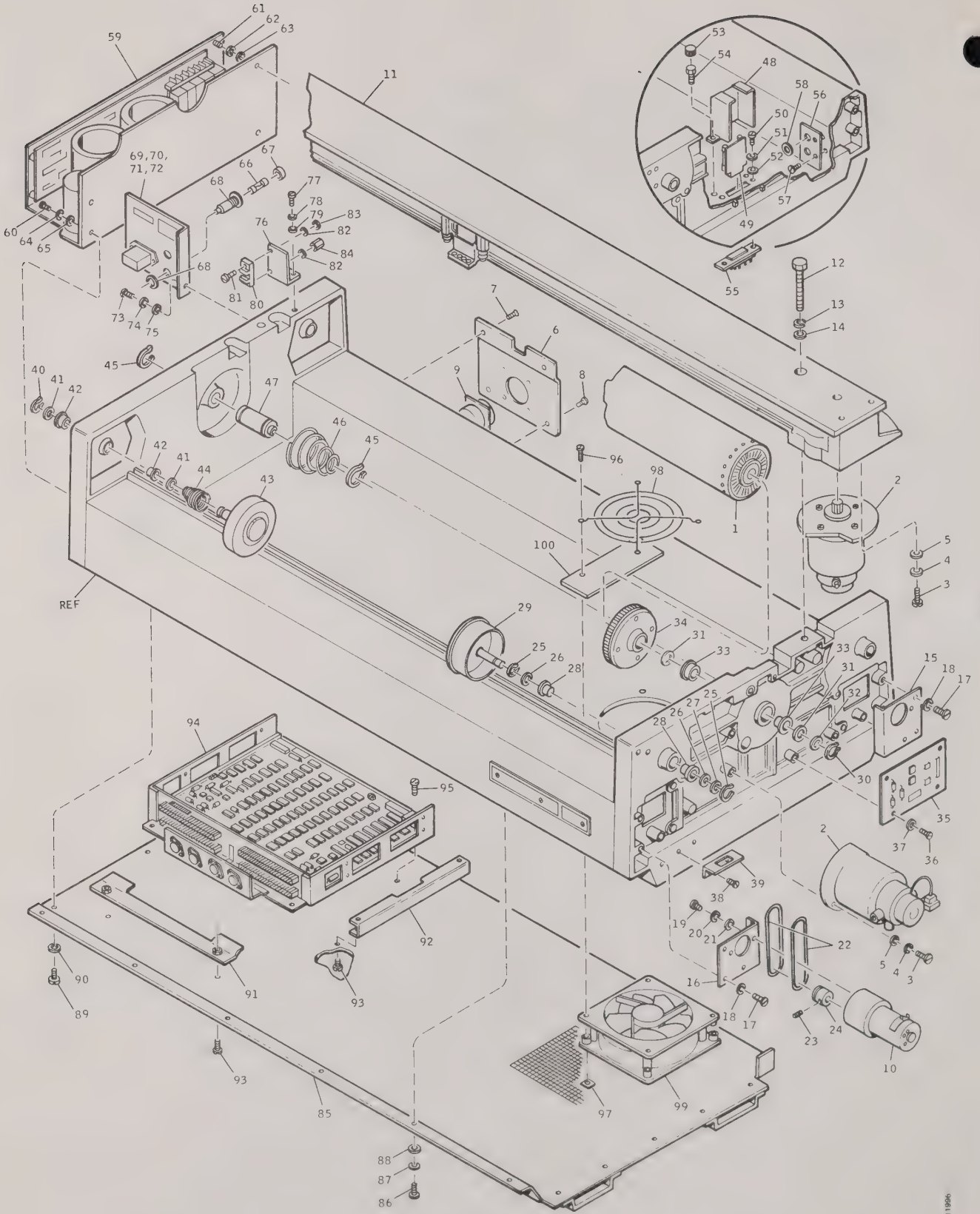

Figure 4-2. Plotter Plot Head Assembly

Figure/ Item No.	I.C. Number	Part Number	Description	Qty. Per Assy.
2-	440590-8	10529-310-000	Plot Head Assy, Plotter (see Figure 4-1 for NHA)	REF
-1	433070-0	11544-211-500	. Drum Assy Plotter	1
	424400-0	20197-101-000	. Accessory Kit, Short Paper, N/I	1
	445870-9	20617-401-000	. Cable Assy, Paper Servo	REF
	445890-7	20616-401-000	. Cable Assy, Motor	REF
	445920-2	20615-401-000	. Cable Assy, I/O	REF
	032500-1	10020-404-000	. Connector, Electrical, I/O (Mating)	REF
	442040-2	20583-401-000	. Cable Assy, Switch	REF
	441860-4	20581-401-000	. Cable Assy, Control	REF
-2	447890-5	10477-310-000	. Motor and Encoder	2
			Attaching Parts	
-3	161290-2	60010-206-359	. Screw, Pan Hd, 10-32 x 1/2 Lg.	3
-4	030090-5	74007-206-191	. Lockwasher, Split	3
-5	171710-7	74002-206-191	. Washer, Flat	3
	449520-6	20018-301-003	. Brush, Motor, N/I	1
-6	442310-9	21750-203-000	. Panel, Signal Input	1
			Attaching Parts	
-7	029620-2	60010-206-247	. Screw, Pan Hd, 6-32 x 3/8 Lg.	2
-8	171360-1	60005-206-247	. Screw, Flat Hd, 6-32 x 3/8 Lg.	2
-9	445920-2	20615-401-000	. Cable I/O	1
	442260-6	21749-203-000	. Panel, Signal Input (OPC), N/I	REF
	451770-2	21818-203-000	. Panel, Signal Input (936), N/I	1
	453310-5	21749-203-500	. Panel, Signal Input (OPC with TTY), N/I	1
	454310-4	21833-203-000	. Panel, Signal Input (IEEE I/O), N/I	1
-10	405240-3	20022-301-000	. Motor, Take-Up	2
-11	440470-3	10526-310-000	. Beam Assy, Plotter (refer to Figure 4-3 for components)	1
			Attaching Parts	
-12	396980-5	60007-206-436	. Screw, Hexagon Hd, 1/4-20 x 2-1/2 Lg.	2
-13	172240-4	74007-206-261	. Lockwasher, Split	2
-14	157710-5	74002-206-261	. Washer, Flat	2
-15	424210-3	21492-203-002	. Bracket, Motor Mtg.	1
-16	424200-4	21492-203-001	. Bracket, Motor Mtg.	1
			Attaching Parts (above 2 items)	
-17	029730-9	60010-206-291	. Screw, Pan Hd, 8-32 x 3/8 Lg.	4
-18	030080-6	74007-206-141	. Lockwasher, Split	4
-19	172060-6	60010-206-256	. Screw, Pan Hd, 10-32 x 5/16 Lg	4
-20	030090-5	74007-206-191	. Lockwasher, Split	4
-21	171710-7	74002-206-191	. Washer, Flat	4
-22	397420-1	62002-206-043	. O Ring, Drive	4
-23	357150-2	60025-206-289	. Setscrew	2
-24	446850-0	12654-204-100	. Pulley, Take-Up	2
-25	019030-6	56003-206-025	. Snap Ring	4
-26	361010-2	74002-206-260	. Washer, Flat	A/R
-27	020010-5	74012-206-262	. Washer, Spring	2
-28	174130-5	10009-207-201	. Bearing, Ball	4
-29	340690-7	10079-210-011	. Pulley, Paper Spool	2
-30	019080-1	56003-206--37	. Snap Ring	1
-31	361000-3	74001-206-380	. Washer, Flat	A/R
-32	360990-6	74012-206-350	. Washer, Spring	1
-33	098650-5	10049-207-200	. Bearing, Ball	2

Figure/ Item No.	I.C. Number	Part Number	Description	Qty. Per Assy.
2-34		20034-905-000	. Drum Drive Coupler and Shaft Assembly	1
-35	440700-3	20869-502-000	. Board Assy, Encoder Preamplifier	1
			Attaching Parts	
-36	151820-8	60010-206-292	. Screw, Pan Hd, 8-32 x 7/16 Lg.	3
-37	229420-5	74006-206-141	. Washer, Flat, Nylon	3
			---*---	
-38	299040-6	60005-206-288	. Screw, Flat Hd, 8-32 x 3/16 Lg.	2
-39	446780-9	21765-203-000	. Plate, Switch	1
-40	019030-6	56003-206-025	. Snap Ring	2
-41	361010-2	74002-206-260	. Washer, Flat	4
-42	174130-5	10009-207-201	. Bearing, Ball	4
-43	365080-1	11587-211-000	. Spool Assy, Adjustable	2
-44	356290-7	21242-203-000	. Spring, Paper Spool	2
-45	094170-8	56003-206-087	. Snap Ring	2
-46	354830-2	12877-204-000	. Spring	1
-47	339940-9	12653-204-000	. Shaft, Drum Adj.	1
-48	440670-8	21491-203-100	. Cover, Light	1
-49	406550-4	20720-502-000	. Lamp Holder Assembly	1
			Attaching Parts (above 2 items)	
-50	029500-6	60010-206-165	. Screw, Pan Hd. 4-40 x 1/4 Lg.	2
-51	030060-8	74007-206-071	. Lockwasher, Split	2
-52	149140-6	74002-206-071	. Washer, Flat	2
			---*---	
-53	404400-4	47015-206-001	. Cap	2
-54	174860-7	60043-206-167	. Screw, Cap, 4-40 x 3/8 Lg.	2
-55	405650-3	30052-404-001	. Connector, 6 Pin	1
-56	443140-9	21764-203-000	. Plate, Sensor, Mtg.	2
			Attaching Parts	
-57	171360-1	60005-206-247	. Screw, Flat Hd, 6-32 x 3/8 Lg.	4
			--.* -	
-58	396950-8	62001-206-014	. O Ring	4
-59	440530-4	20190-402-000	. Power Supply Assy, Plotter (refer to Figure 4-4 for components)	1
			Attaching Parts	
-60	151820-8	60010-206-292	. Screw, Pan Hd, 8-32 x 7/16 Lg.	2
-61	447250-2	60025-206-294	. Setscrew	2
-62	171030-0	50001-206-014	. Nut, Hexagon	2
-63	447240-3	74009-206-041	. Lockwasher, Internal Tooth	2
-64	030080-6	74007-206-141	. Lockwasher, Split	2
-65	171750-3	74002-206-141	. Washer, Flat	2
			---* --	
-66	017800-4	40101-304-022	. Fuse	2
-67	433710-1	43009-206-101	. Cap, Bayonet	2
		43009-206-102	. Cap, Bayonet Export, N/I	2
-68	433700-2	43009-206-001	. Fuseholder	2
-69	402040-0	10026-213-000	. Label, Warning	1
-70	435590-5	10006-303-101	. Indicator, Elapsed Time	1
-71	397170-2	10125-509-006	. Line Filter	1
-72	440680-7	21739-203-000	. Panel, Input	1
			Attaching Parts	
-73	029730-9	60010-206-291	. Screw, Pan Hd, 8-32 x 3/8 Lg.	2
-74	030080-6	74007-206-141	. Lockwasher, Split	2
-75	171750-3	74002-206-141	. Washer, Flat	2
			-* -	
-76	439760-0	21743-203-000	. Angle	2
			Attaching Parts	
-77	029520-4	60010-206-167	. Screw, Pan Hd, 4-40 x 3/8 Lg.	2
-78	030060-8	74007-206-071	. Lockwasher, Split	2

Figure/ Item No.	I.C. Number	Part Number	Description	Qty. Per Assy.
2-79	149140-6	74002-206-071	. Washer, Flat	2
			---*---	
-80	426050-1	50115-507-000	. Photo Sensor	2
			Attaching Parts	
-81	157800-0	60010-206-169	. Screw, Pan Hd, 4-40 x 1/2 Lg.	2
-82	030060-8	74007-206-071	. Lockwasher, Split	2
-83	161650-7	50001-206-002	. Nut, Hex	1
-84	386720-7	72016-206-004	. Standoff	1
			---*---	
-85	440660-9	21484-203-100	. Base Pan	1
			Attaching Parts	
-86	029660-2	60010-206-247	. Screw, Pan Hd, 6-32 x 3/8 Lg.	6
-87	030070-7	74007-206-111	. Lockwasher, Split	6
-88	163750-3	74002-206-111	. Washer, Flat	6
			---*---	
-89	151820-8	60010-206-292	. Screw, Pan Hd, 8-32 x 7/16 Lg.	5
-90	151790-3	74008-206-141	. Lockwasher, Internal Tooth	5
-91	440650-0	21512-203-100	. Bracket	2
-92	442320-8	14379-204-000	. Bracket, Channel	1
-93	029620-2	60010-206-247	. Screw, Pan Hd, 6-32 x 3/8 Lg.	6
-94	442050-1	10503-310-000	. Electronics Assy, Logic Driver (refer to Figure 4-5 for components)	1
			Attaching Parts	
-95	171890-7	60010-206-245	. Screw, Pan Hd, 6-32 x 1/4 Lg.	2
			---*---	
-96	171910-3	60010-206-252	. Screw, Pan Hd, 6-32 x 7/8 Lg.	4
-97	412340-2	50069-206-000	. Clip	4
-98	289290-9	50015-301-000	. Guard, Fan	1
-99	396450-9	30005-301-000	. Fan	1
-100	415970-3	21591-203-000	. Baffle	1

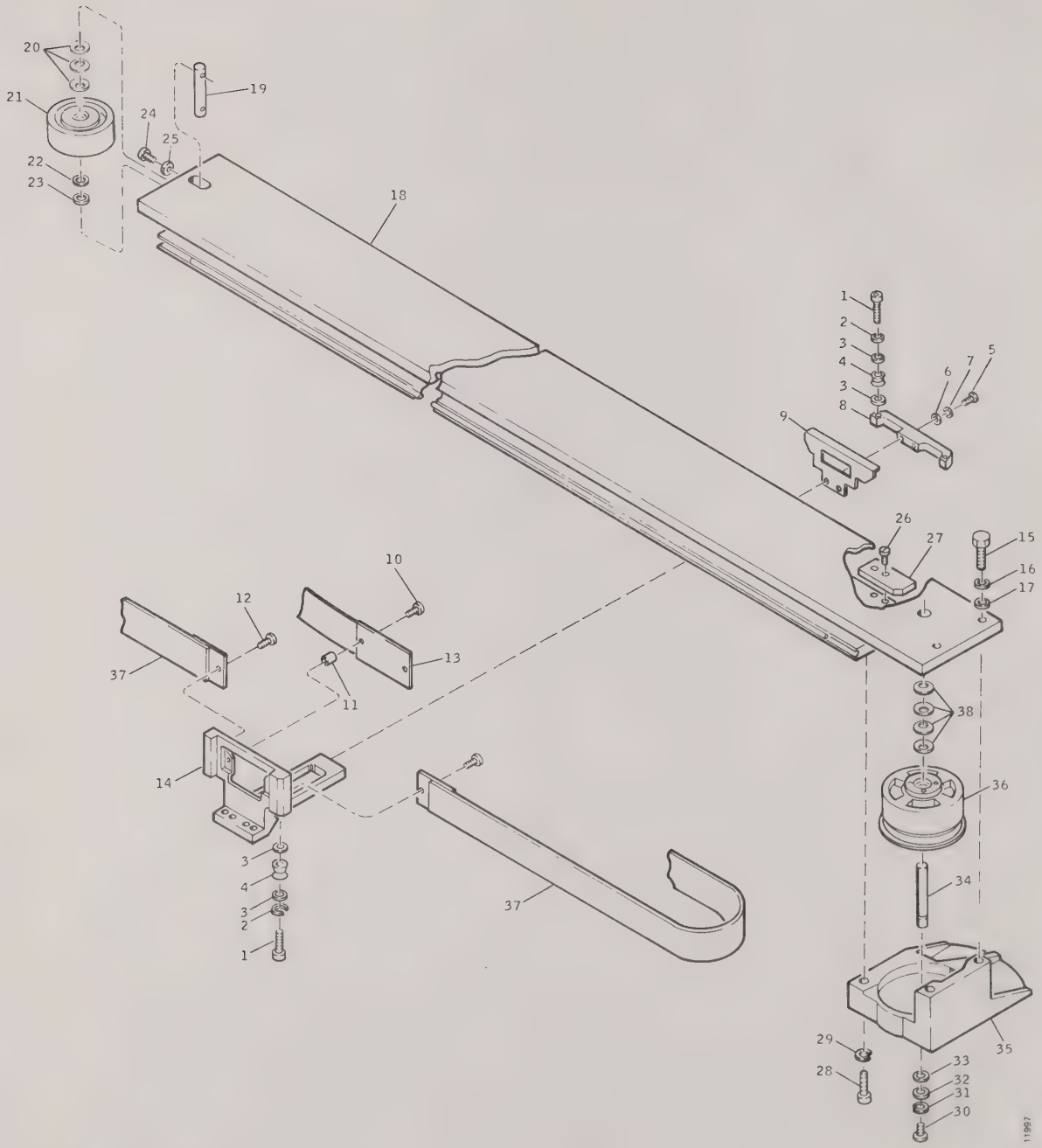

Figure 4-3. Plotter Beam Assembly

2B8

Figure/ Item No.	I.C. Number	Part Number	Description	Qty. Per Assy.
3-	440470-3	10526-310-000	Beam Assy, Plotter (see Figure 4-2 for NHA)	REF
	444050-9	10523-310-011	. Carriage Assy, Drum Plotter	1
-1	356990-2	60028-206-209	. . Screw, Socket Hd Cap 5-40 x 1/2 Lg.	4
-2	030070-7	74007-206-111	. . Lockwasher, Split, No. 6	4
-3	025830-1	10881-204-000	. . Spacer	10
-4	415280-7	10090-207-200	. . Bearing	4
-5	151800-0	60010-206-169	. . Screw, Pan Hd, 4-40 x 1/2 Lg.	2
-6	149140-6	74002-206-071	. . Washer, Flat	2
-7	030060-8	74007-206-071	. . Lockwasher, Split	2
-8	440240-0	14375-204-000	. . Bracket, Spring	1
-9	440520-5	21744-203-000	. . Actuator, Switch	1
-10	181160-3	60005-206-170	. . Screw, Flat Hd, 4-40 x 5/8 Lg.	2
-11	356960-5	72035-206-068	. . Standoff	2
-12	360810-6	13235-204-000	. . Screw, Band	2
-13	444070-7	20579-401-011	. . Cable Assembly	1
-14	440250-9	14354-204-000	. . Carriage, Drum Plotter	1
-15	365640-2	60007-206-425	. Screw, Hex Hd, 14/-20 x 1/2 Lg.	2
-16	172240-4	74007-206-261	. Lockwasher, Split	2
-17	157710-5	74002-206-261	. Washer, Flat	2
-18	440480-2	11723-211-000	. Beam and Rod Assembly	1
-19	159570-1	11345-204-000	. Shaft, Pulley, Crowned	1
-20	381200-5	73029-206-111	. Washer, Beeville	3
-21		20041-905-000	. Pulley Assy, Drive	1
-22	195970-9	74003-206-202	. Washer, Plain	1
-23	153840-4	74002-206-351	. Washer, Falt	1
-24	388320-4	60041-206-363	. Screw, Pan Hd, 10-32 x 1.00 Lg.	2
-25	204310-3	74033-206-014	. Washer, Plain	2
-26	029520-4	60010-206-167	. Screw, Pan Hd, 4-40 x 3/8 Lg.	2
-27	377180-5	13485-204-000	. Clamp, Cable	1
-28	297900-3	60028-206-429	. Screw, Socket Hd Cap, 1/4-20 x 1.00 Lg.	2
-29	172240-4	74007-206-261	. Lockwasher, Split	2
-30	151820-8	60010-206-292	. Screw, Pan Hd, 8-32 x 7/16 Lg.	1
-31	030080-6	74007-206-141	. Lockwasher, Split	1
-32	171750-3	74002-206-141	. Washer, Flat	1
-33	171710-7	74002-206-191	. Washer, Flat	1
-34	340730-1	12658-204-000	. Shaft, Pulley, Drive	1
-35	442010-5	14374-204-000	. Support, Motor, Carriage Drive	1
-36		20033-905-000	. Pulley Assy, Drive	1
-37	412330-3	11356-211-000	. Band Assembly	1
-38	381200-5	73029-206-111	. Washer, Beeville	4

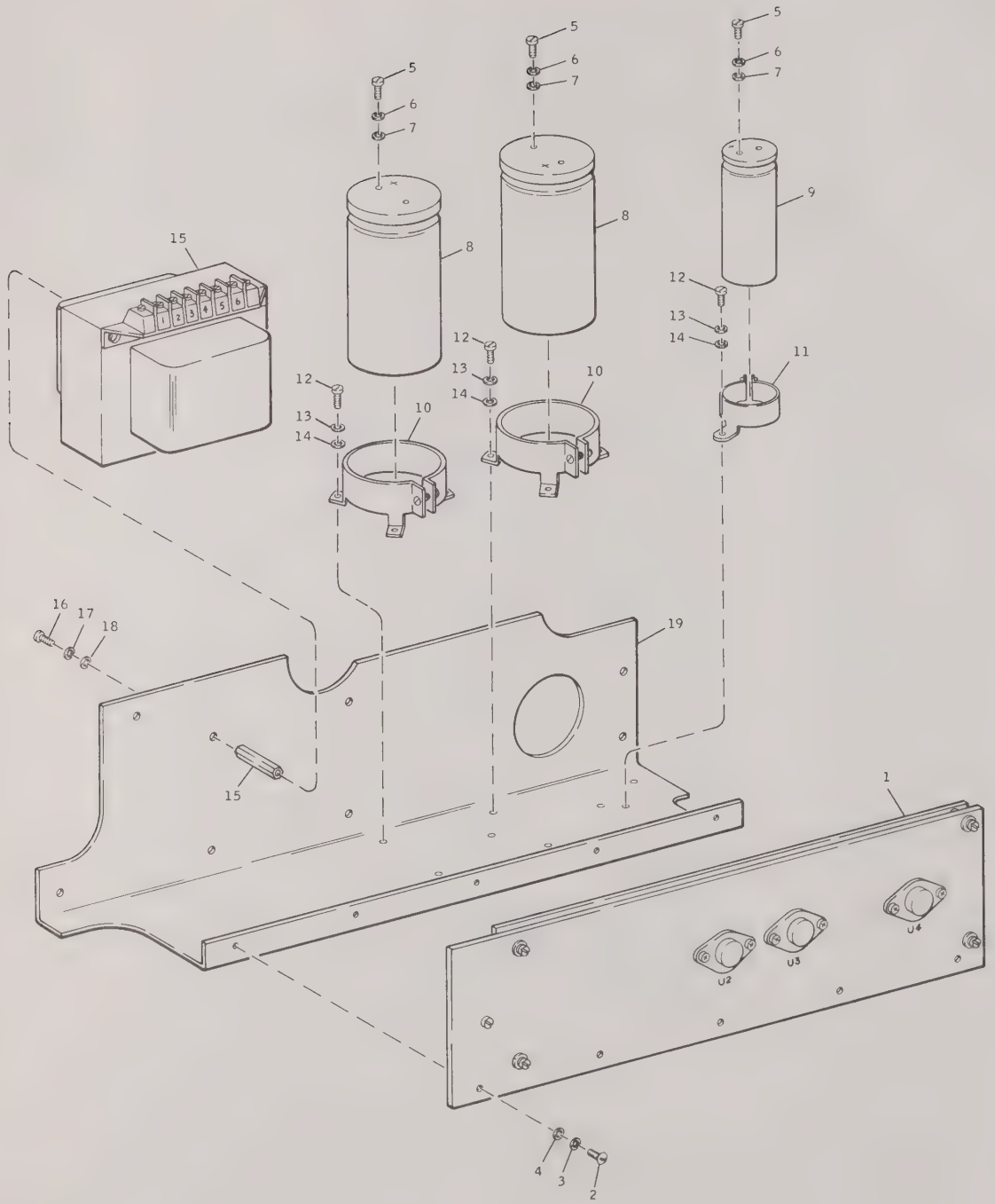

Figure 4-4. Plotter Power Supply Assembly

2B10

Figure/ Item No.	I.C. Number	Part Number	Description	Qty. Per Assy.
4-	440530-4	20190-402-000	Power Supply Assy, Plotter (see Figure 4-2 for NHA)	REF
-1	440560-1	20867-502-000	. Board Assy, Power Supply	1
			Attaching Parts	
-2	029620-2	60010-206-247	. Screw, Pan Hd, 6-32 x 3/8 Lg.	5
-3	030070-7	74007-206-111	. Lockwasher, Split	5
-4	163750-3	74002-206-111	. Washer, Flat	5
			—— -*———	
	357720-2	40106-304-018	. . Fuse, 3 Amp, N/I	2
	442760-5	40106-304-020	. . Fuse, 5 Amp, N/I	2
	017860-8	40102-304-030	. . Fuse, 5 Amp, N/I	2
	433500-6	70207-506-350	. . Rectifier, Bridge, CR1 N/I	1
	350190-5	70206-506-365	. . Rectifier, Bridge, CR1001, MDA3502, N/I	1
	446220-6	70208-506-350	. . Rectifier, Bridge, CR2, N/I	1
	436550-8	21506-304-002	. . Relay, K1, N/I	1
	361670-3	30405-508-000	. . Regulator, U2, 7815CK, N/I	1
	391990-9	30410-508-000	. . Regulator, U4, LM323K, N/I	1
	397660-2	30411-508-000	. . Regulator, U3, LM320K15, N/I	1
	341420-8	10418-508-000	. . Integrated Circuit, U1, SN7406N, N/I	1
-5	172060-6	60010-206-356	. Screw, Pan Hd, 10-32 x 5/16 Lg.	6
-6	030090-5	74007-206-191	. Lockwasher, Split	6
-7	164430-1	74002-206-180	. Washer, Flat	6
-8	440820-9	10116-505-458	. Capacitor, 32000 MF, 25V	2
-9	186500-5	10105-505-474	. Capacitor, 15000 MF, 15V	1
-10	189580-4	10026-206-003	. Clamp, Capacitor	2
-11	033420-1	10026-206-002	. Clamp, Capacitor	1
			Attaching Parts (above two items)	
-12	171890-7	60010-206-245	. Screw, Pan Hd, 6-32 x 1/4 Lg.	9
-13	030070-7	74007-206-111	. Lockwasher, Split	9
-14	163750-3	74002-206-111	. Washer, Flat	9
			——-*———	
-15	440570-0	10179-403-000	. Transformer, 50/60 Hz	1
			Attaching Parts	
-16	029740-8	60010-206-293	. Screw, Pan Hd, 8-32 x 1/2 Lg.	4
-17	030080-6	74007-206-141	. Lockwasher, Split	4
-18	171750-3	74002-206-111	. Washer, Flat	4
			——-*———	
-19	440540-3	21733-203-000	. Chassis, Power Supply	1

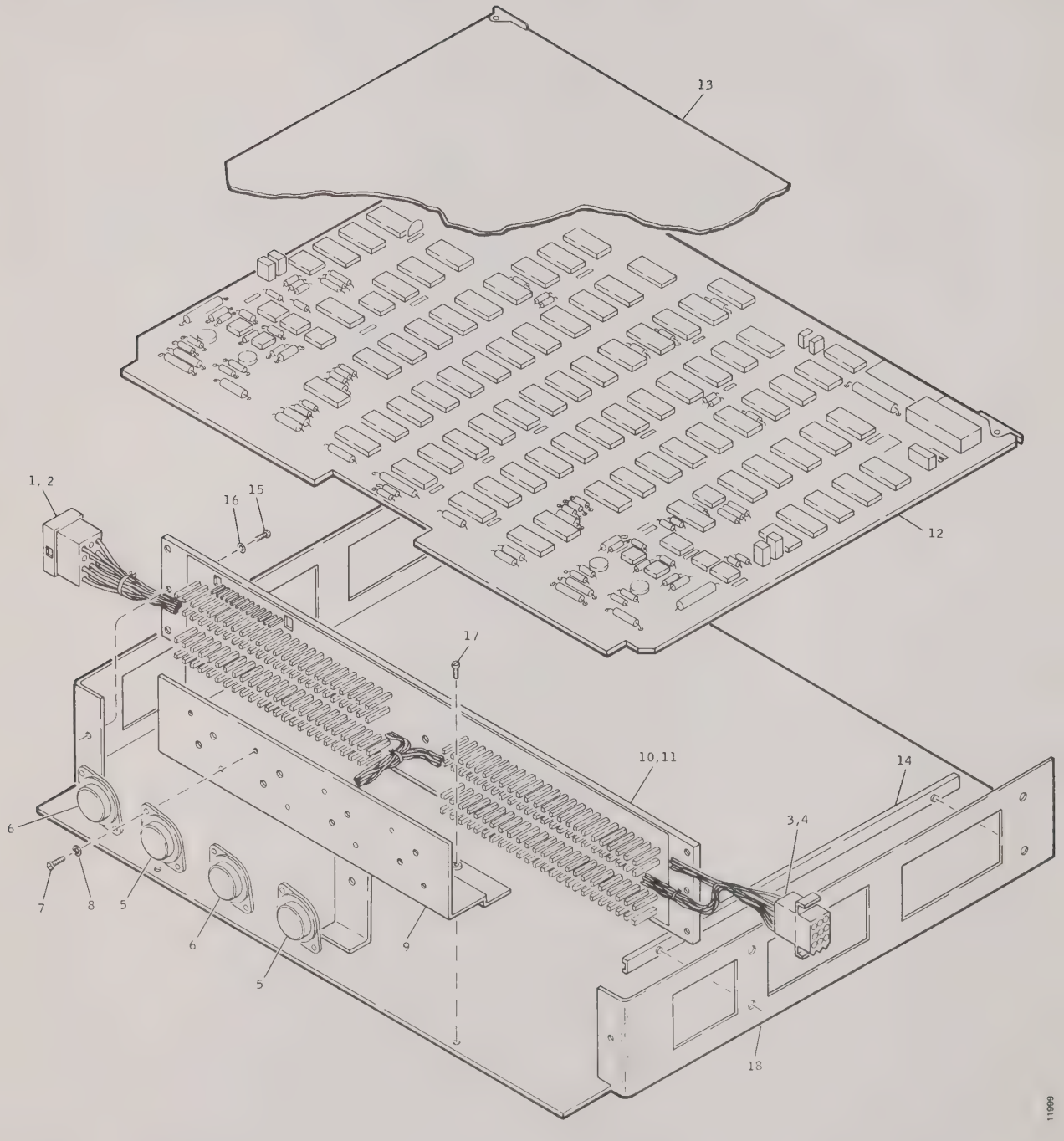

Figure 4-5. Plotter Electronic Assembly

2C2

Figure/ Item No.	I.C. Number	Part Number	Description	Qty. Per Assy.
5-	442050-1	10530-310-000	Electronics Assy, Logic Driver (see Figure 4-2 for NHA)	REF
	442070-1	20808-502-000	. Board Assy, Master Interconnect	1
-1	301120-2	90321-404-002	. . Plug, Electrical, P2010	1
-2	218430-7	80353-404-001	. . Contact, Male	10
-3	236690-4	80320-404-002	. . Connector, Recpt, P2040	1
-4	218440-6	80354-404-001	. . Contact	8
-5	397670-1	20317-507-000	. . Transistor, 2N6050	2
-6	397680-1	20420-507-000	. . Transistor, 2N6057	2
			Attaching Parts	
-7	029620-2	60010-206-247	. . Screw, Pan Hd, 6-32 x 3/8 Lg.	8
-8	030070-7	74007-206-111	. . Lockwasher, Split	8
			---*---	
	190160-2	12015-206-001	. . Socket, Transistor, N/I	4
	226370-5	10502-508-450	. . Capacitor, 0.01 MF, 100v, N/I	4
-9	442060-0	21729-203-000	. . Bracket, Heat Sink	1
-10	327520-1	30032-401-001	. . Connector, Circuit Board	4
-11	443790-1	20868-512-000	. . Board, Master Interconnect	1
-12	441940-4	20866-502-000	. Board Assy, Logic Drive	1
-13	441950-3	20865-502-000	. Board Assy, I/O Driver (Not this assy – see Figure 4-1)	1
		20872-502-000	. Board Assy, Optional 936	1
-14	402710-8	37008-206-012	. Guide, Card	4
-15	029510-5	60010-206-166	. Screw, Pan Hd, 4-40 x 5/16 Lg.	6
-16	150700-3	74008-206-071	. Lockwasher, Internal Tooth	3
-17	269880-1	60005-206-246	. Screw, Flat Hd, 6-32 x 5/16 Lg.	2
	443370-7	34021-206-000	. Bumper, Rubber, N/I	2
-18	439150-4	21709-203-000	. Chassis	1

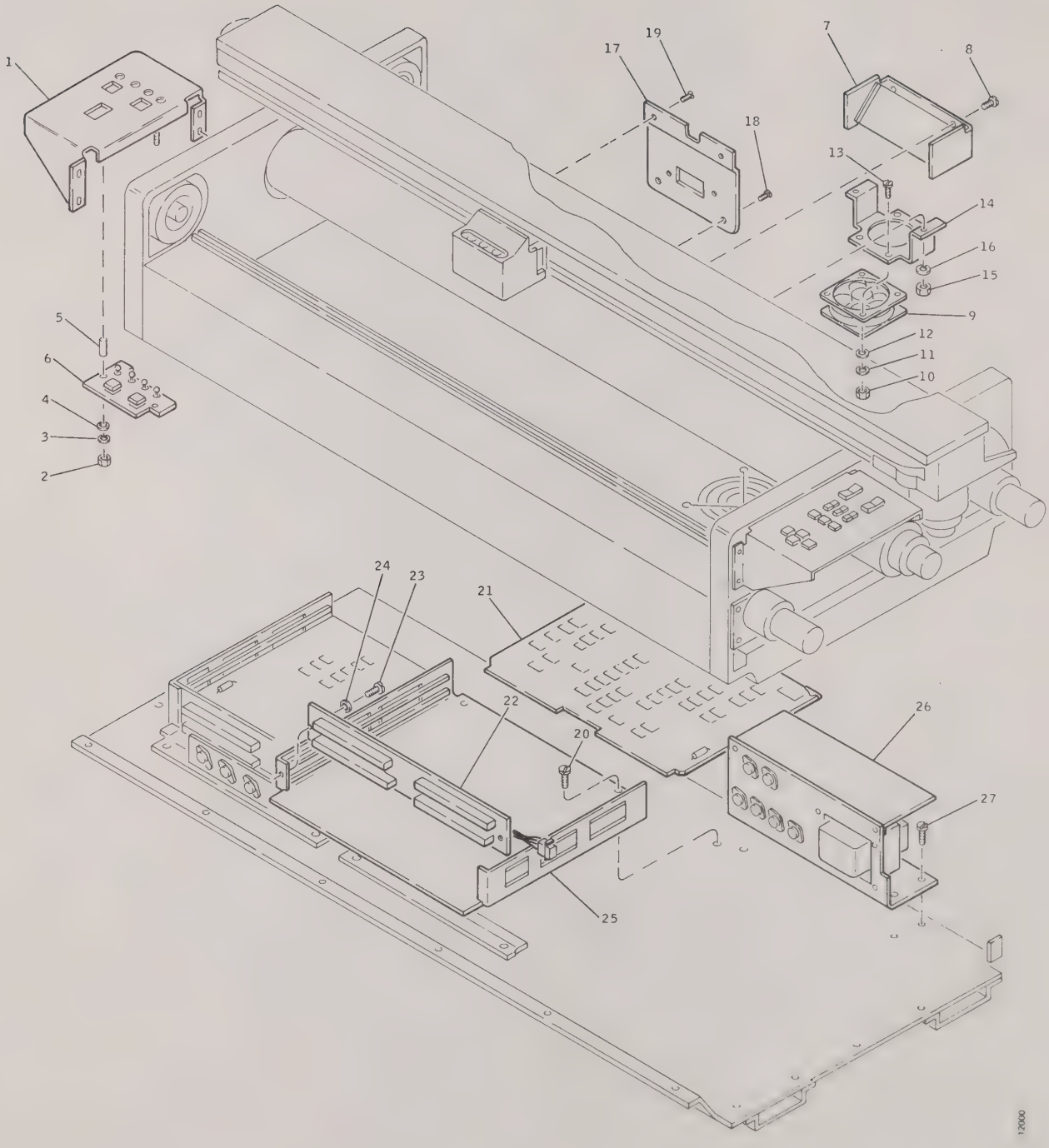

Figure 4-6. OPC Modification Kit

2C4

Figure/ Item No.	I.C. Number	Part Number	Description	Qty. Per Assy.
6-	442210-1	20388-801-000	Kit, Modification, OPC	REF
-1	442220-0	21762-203-000	. Panel, Control OPC, LH	1
			Attaching Parts	
-2	050590-9	50001-206-012	. Nut, Hexagon	4
-3	030070-7	74007-206-111	. Lockwasher, Split	4
-4	163750-3	74002-206-111	. Washer, Flat	4
			---*---	
-5	444090-5	72016-206-021	. Spacer, 6-32 x 5/8 Lg.	4
-6	442230-9	20860-502-000	. Board Assy, Control Panel	1
	438260-2	10429-304-001	. . Switch, Pushbutton, S1, N/I	2
	442670-4	11620-304-001	. . Button, Switch, N/I	2
	374210-3	50023-404-001	. . Socket, IC, 16 Pin, N/I	1
	173390-6	10212-504-336	. . Resistor, 220 ohm, 5%, 1/4W, R1-4, N/I	4
	344450-2	10530-703-001	. . Lamp, Led, Red, DS1-4, N/I	4
	443200-1	20860-512-000	. . Board, OPC Display, N/I	1
-7	442240-8	21747-203-000	. Baffle, Air	1
			Attaching Parts	
-8	029620-2	60010-206-247	. Screw, Pan Hd, 6-32 x 3/8 Lg.	4
			---*---	
-9	442340-6	30006-301-000	. Fan	1
			Attaching Parts	
-10	050590-9	50001-206-012	. Nut, Hexagon	4
-11	030070-7	74007-206-111	. Lockwasher, Split	4
-12	163750-3	74002-206-111	. Washer, Flat	4
-13	029620-2	60010-206-247	. Screw, Pan Hd, 6-32 x 3/8 Lg.	4
			---*---	
-14	442250-7	21746-203-000	. Chassis, Fan Mtg.	1
			Attaching Parts	
-15	050590-9	50001-206-012	. Nut, Hexagon	2
-16	030070-7	74007-206-111	. Lockwasher, Split	2
			---*---	
-17	442260-6	21749-203-000	. Panel, Signal Input	1
			Attaching Parts	
-18	029620-2	60010-206-247	. Screw, Pan Hd, 6-32 x 3/8 Lg.	2
-19	171360-1	60005-206-247	. Screw, Flat Hd, 6-32 x 3/8 Lg.	2
			---*---	
	441050-2	10528-310-000	. Electronics Assy, OPC	1
			Attaching Parts	
-20	029620-2	60010-206-247	. Screw, Pan Hd, 6-32 x 3/8 Lg.	4
			---*---	
-21	440920-7	20833-502-000	. . Board Assy, Control	1
-22	441060-1	20835-502-000	. . Board Assy Master	1
			Attaching Parts	
-23	029510-5	60010-206-166	. . Screw, Pan Hd, 4-40 x 5/16 Lg.	3
-24	150700-3	74008-206-071	. . Lockwasher, Internal Tooth	3
			--- *	
-25	439150-4	21709-203-000	. . Chassis, Electronics	1
-26	441090-8	20189-402-000	. Power Supply Assy, OPC (refer to Figure 4-7 for components) 50/60 Hz	1
			Attaching Parts	
-27	029620-2	60010-206-247	. Screw, Pan Hd, 6-32 x 3/8 Lg.	4
			--- *---	
	172680-1	11139-204-000	. Plate, Modification, N/I	1

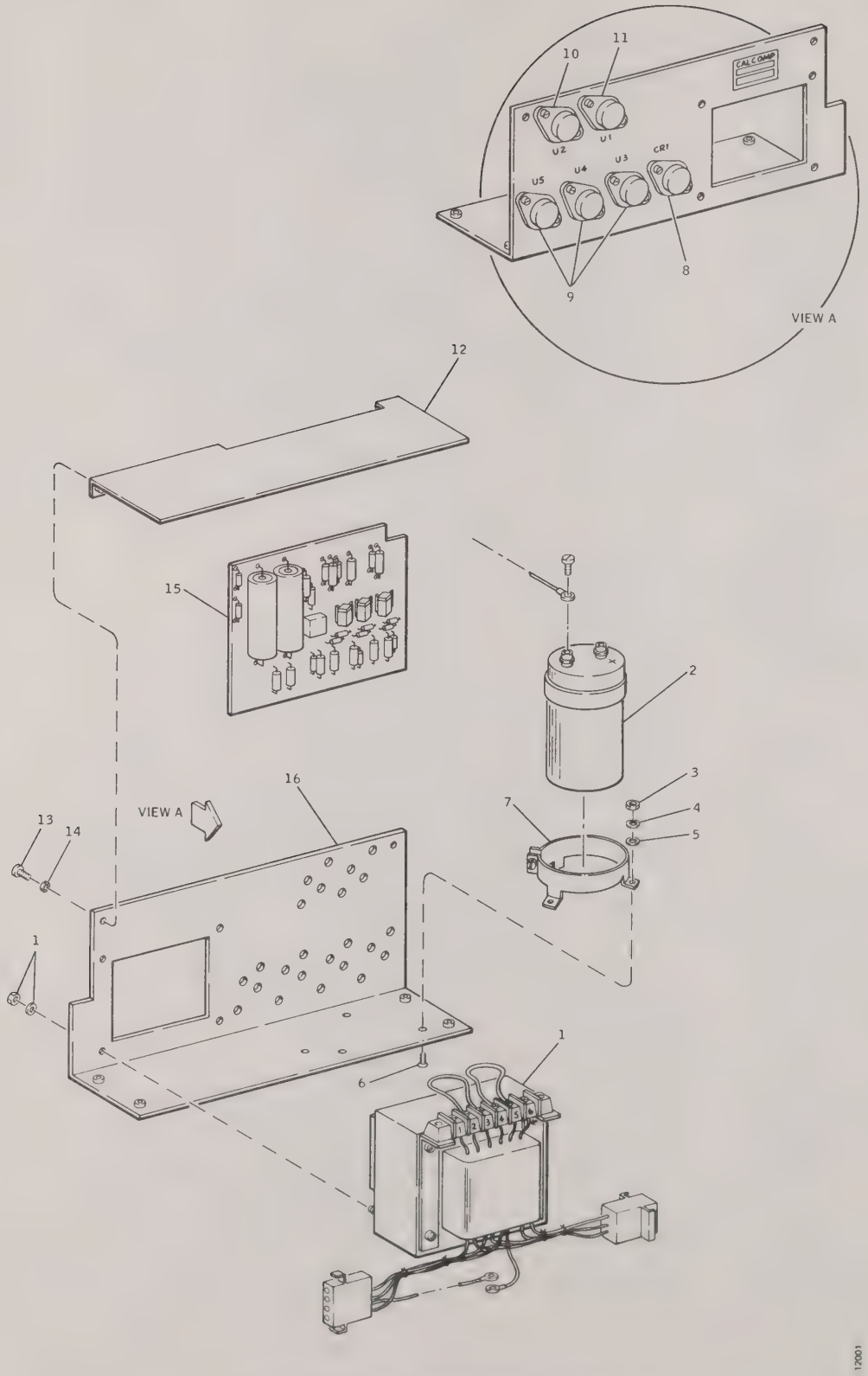

Figure 4-7. OPC Power Supply Assembly

Figure/ Item No.	I.C. Number	Part Number	Description	Qty. Per Assy.
7-	441090-8	20189-402-000	Power Supply Assy, OPC (see Figure 4-6 for NHA)	REF
-1	435580-6	10181-403-000	. Transformer, T1, 50/60 Hz	1
-2	433510-5	10149-505-471	. Capacitor, C1	1
			Attaching Parts	
-3	050590-9	50001-206-012	. Nut, Hexagon	3
-4	030070-7	74007-206-111	. Lockwasher, Split	3
-5	163750-3	74002-206-111	. Washer, Flat	3
-6	171360-1	60005-206-247	. Screw, Flat Hd, 6-32 x 3/8 Lg.	3
-7	033420-1	10021-206-002	. Clamp	1
			---*---	
-8	433490-0	70403-506-350	. Diode Assembly, CR1	1
-9	391990-9	30410-508-000	. Regulator, 3 amp, 5v, U3-5	3
-10	435570-7	30415-508-000	. Regulator, 1 amp, 12v, U2	1
-11	371460-7	30406-508-000	. Regulator, Voltage, +12v, U1	1
-12	439130-6	21748-203-000	. Cover, Power Supply	1
			Attaching Parts	
-13	029610-3	60010-206-246	. Screw, Pan Hd, 6-32 x 5/16 Lg.	2
-14	030010-3	74008-206-111	. Lockwasher, Internal Tooth	2
			---*---	
-15	440930-6	20834-502-000	. Board Assy, Power Supply	1
	006680-3	10033-204-000	. Plate Identification, N/I	1
-16	439140-5	21720-203-000	. Chassis, Power Supply	1

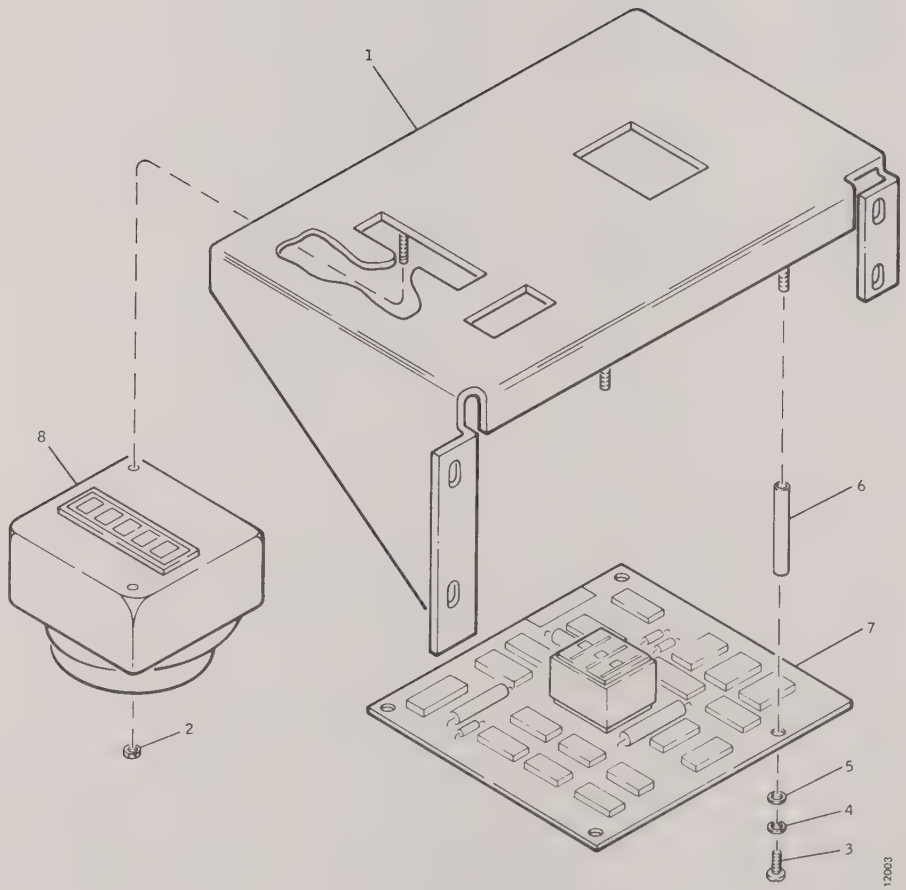

Figure 4-8. Scale Factor Modification Kit

2C8

Figure/ Item No.	I.C. Number	Part Number	Description	Qty. Per Assy.
8-	442270-3	20390-801-000	Kit, Modification, Scale Factor	REF
-1	442300-0	21717-203-000	. Panel, Control, Scale Factor, LH	1
			Attaching Parts	
-2	050590-9	50001-206-012	. Nut, Hexagon	2
-3	029620-2	60010-206-247	. Screw, Pan Hd, 6-32 x 3/8 Lg.	4
-4	030070-7	74007-206-111	. Lockwasher, Split	4
-5	163750-3	74002-206-111	. Washer, Flat	4
-6	444100-2	72016-206-027	. Spacer	4
-7	440150-1	20842-502-000	. Board Assy, Control Panel, Scale Fact	1
	440980-1	10129-304-008	. . Switch, Dup, 8 Position, SPST, S2, N/I	1
	345810-6	11205-304-001	. . Switch, Thumbwheel, 2 Position, S1, N/I	1
	109160-0	10212-504-432	. . Resistor, 4.7K, 5%, 1/4w, R1, 2, 6, N/I	3
	438120-8	60109-504-432	. . Resistor Network, 4.7K, 2%, 3W, R3-5, N/I	3
	127740-9	10202-505-328	. . Capacitor, 59MF, 10%, 10V, C4, N/I	1
	303450-1	10507-505-190	. . Capacitor, .068 MF, 50%, 25V, C1-3, 5-7, N/I	6
	341420-8	10418-508-000	. . Integrated Circuit, U1, 5, SN7406N, N/I	2
	409780-4	10486-508-000	. . Integrated Circuit, U2, 4, 7, DM74LS00N, N/I	3
	341430-7	10419-508-000	. . Integrated Circuit, U6, 10, SN74184N, N/I	2
	417660-8	10532-508-000	. . Integrated Circuit, U8, 9, 2N74LS283N	2
	360140-8	10427-508-000	. . Integrated Circuit, U11, 12, 14, 15, SN74N87N, N/I	4
	411730-5	10510-508-000	. . Integrated Circuit, U13, 16, SN74LS85N, N/I	2
	411540-4	10496-508-000	. . Integrated Circuit, U3, SN74LS51N, N/I	1
	444490-7	20842-512-000	. . Board, Scale Factor, N/I	1
-8	408710-2	10005-303-001	. Meter, Run Time, 60 Hz	1
	408720-1	10005-305-002	. Meter, Run Time, 50 Hz	1
	172680-1	11139-204-000	. Plate, Identification, N/I	1

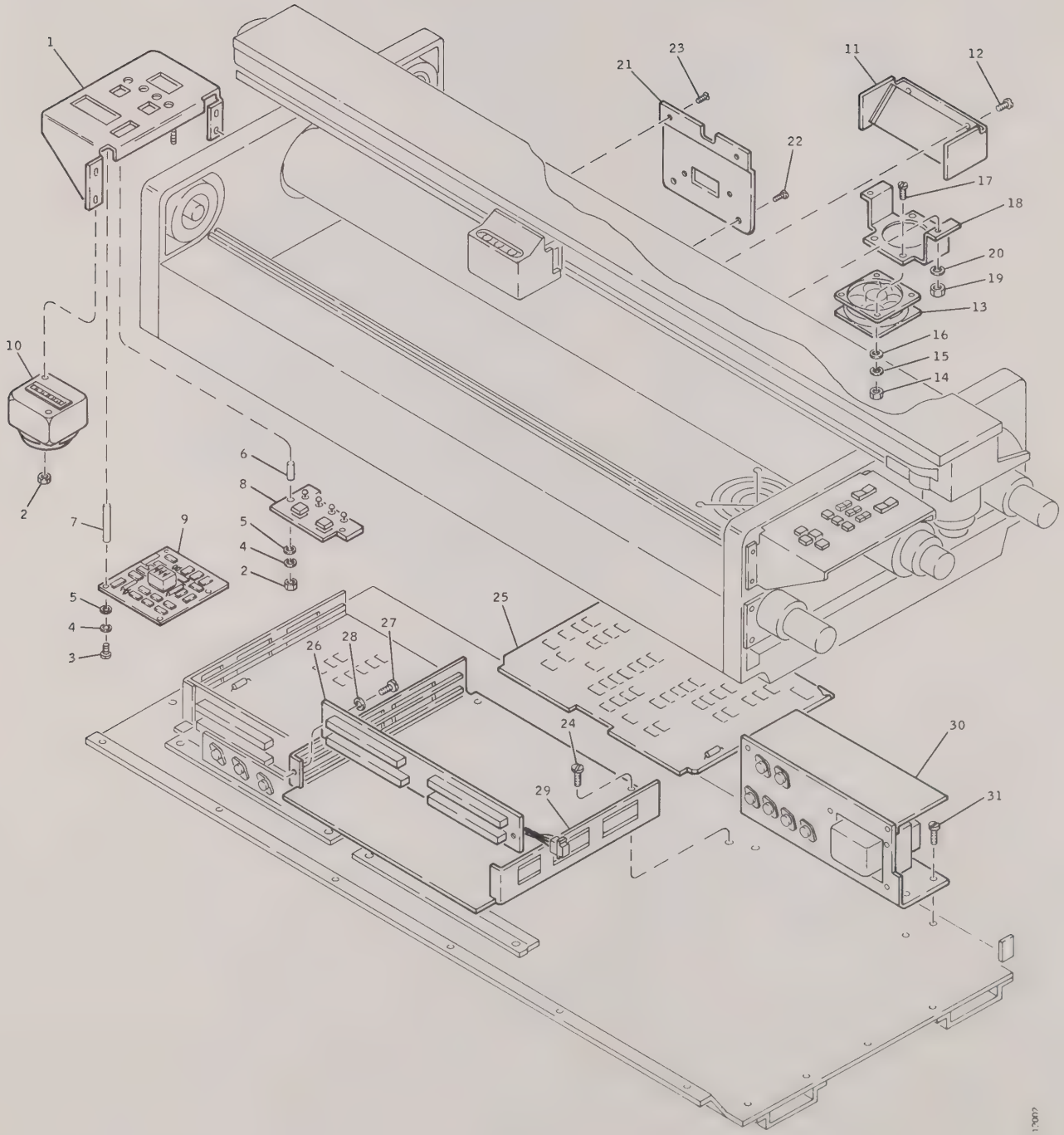

Figure 4-9. OPC + Scale Factor Modification Kit

2C10

Figure/ Item No.	I.C. Number	Part Number	Description	Qty. Per Assy.
9-	442270-5	20389-801-000	. Kit, Modification, OPC + Scale Factor	REF
-1	442280-4	21760-203-000	. Panel, Control, LH	1
			Attaching Parts	
-2	050590-9	50001-206-012	. Nut, Hexagon	2
-3	029620-2	60010-206-247	. Screw, Pan Hd, 6-32 x 3/8 Lg.	4
-4	030070-7	74007-206-111	. Lockwasher, Split	6
-5	163750-3	74002-206-111	. Washer, Flat	6
			---*---	
-6	444090-5	72016-206-021	. Spacer, Threaded	2
-7	444100-2	72016-206-027	. Spacer, Threaded	4
-8	442230-9	20860-502-000	. Board Assy, Control Panel, OPC	1
	438260-2	10429-304-001	. . Switch, Pushbutton, S1, 2, N/I	2
	442670-4	11620-304-001	. . Button, Switch, N/I	2
	374210-3	50023-404-001	. . Socket, IC, 16 Pin, N/I	
	173390-6	10212-504-336	. . Resistor, 220 ohm, 5% 1/4W, R1-4, N/I	
	344450-2	10503-703-001	. . Lamp, Led, Red, DS1-4, N/I	4
	443200-1	20860-512-000	. . Board, OPC Display, N/I	1
-9	440150-1	20842-502-000	. Board Assy, Control Panel, Scale Factor	1
	400980-1	10129-304-008	. . Switch, Dip, 8 Position, SPST, S2, N/I	1
	345810-6	11205-304-001	. . Switch, Thumbwheel, 2 Position, S1, N/I	1
	109160-0	10212-504-432	. . Resistor, 4.7K, 5%, 1/4W, R1, 2, 6, N/I	3
	438120-8	60109-504-432	. . Resistor Network, 4.7K, 2%, 3W, R3-5, N/I	3
	127740-9	10202-505-328	. . Capacitor, 39 MF, 10%, 10V, C4, N/I	1
	303450-1	10507-505-190	. . Capacitor, .068 MF, 50%, 25V, C1-3, 5-7, N/I	6
	341420-8	10418-508-000	. . Integrated Circuit, U1, 5, SN7406N, N/I	2
	409780-4	10486-508-000	. . Integrated Circuit, U2, 4, 7, DN74LS00N, N/I	3
	341430-7	10419-508-000	. . Integrated Circuit, U6, 10, SN74184N, N/I	2
	417660-8	10532-508-000	. . Integrated Circuit, U8, 9, 2N74LS283N, N/I	2
	460140-8	10427-508-000	. . Integrated Circuit, U11, 12, 14, 15, SN74U87N, N/I	4
	411730-5	10510-508-000	. . Integrated Circuit, U13, 16, SN74LS85N, N/I	2
	411540-8	10494-508-000	. . Integrated Circuit, U3, SN74LS10N, N/I	1
	444490-7	20842-512-000	. . Board, Scale Factor, N/I	1
-10	408710-2	10005-303-001	. Meter, Run Time, 60 Hz	1
	408720-1	10005-305-002	. Meter, Run Time, 50 Hz	1
-11	442240-8	21747-203-000	. Baffle, Air	1
			Attaching Parts	
-12	029620-2	60010-206-247	. Screw, Pan Hd, 6-32 x 3/8 Lg.	4
			---*---	
-13	442340-6	30006-301-000	. Fan	1
			Attaching Parts	
-14	050590-9	50001-206-012	. Nut, Hexagon	4
-15	030070-7	74007-206-111	. Lockwasher, Split	4
-16	163750-3	74002-206-111	. Washer, Flat	4
-17	029620-2	60010-206-247	. Screw, Pan Hd, 6-32 x 3/8 Lg.	4
			--*--	
-18	442250-7	21746-203-000	. Chassis, Fan Mtg.	1
			Attaching Parts	
-19	050590-9	50001-206-012	. Nut, Hexagon	2
-20	030070-7	74007-206-111	. Lockwasher, Split	2
			--*---	
-21	442260-6	21749-203-000	. Panel, Signal Input	1
			Attaching Parts	
-22	029620-2	60010-206-247	. Screw, Pan Hd, 6-32 x 3/8 Lg.	2
-23	171360-1	60005-206-247	. Screw, Flat Hd, 6-32 x 3/8 Lg.	2
			---*--	
	441050-2	10528-310-000	. Electronics Assy. OPC	1
			Attaching Parts	

Figure/ Item No.	I.C. Number	Part Number	Description	Qty. Per Assy.
9-24	029620-2	60010-206-247	. Screw, Pan Hd, 6-32 x 5/8 Lg.	2
			---*---	
-25	440920-7	20833-502-000	. . Board Assy Control	1
-26	441060-1	20835-502-000	. . Board Assy Master Interconnect	1
			Attaching Parts	
-27	029510-5	60010-206-166	. . Screw, Pan Hd, 4-40 x 5/16 Lg.	3
-28	150700-3	74008-206-071	. . Lockwasher, Internal Tooth	3
			---*---	
-29	439150-4	21709-203-000	. . Chassis, Master Interconnect	1
-30	441090-8	20189-402-000	. Power Supply Assy, OPC (refer to Figure 4-7 for components), 50/60 Hz	1
			Attaching Parts	
-31	029620-2	60010-206-247	. Screw, Pan Hd, 6-32 x 3/8 Lg.	4
			---*---	
	172680-1	11139-204-000	. Plate, Modification, N/I	1

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